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SOUTH AFRICAN QUESTIONS FROM AN ENGINEERING STANDPOINT.

By Albert Williams, Jr.

The Vaal River.

SO much has been printed and read about South Africa during the past three years, and more especially in recent months and weeks, that an extensive, if somewhat superficial, mass of information has been disseminated. It is not necessary, therefore, even if it were possible in a brief review of the situation, to enter into details, though it may be worth while to glance at some of the more salient features. Readers of THE ENGINEERING MAGAZINE have had very thorough accounts of the technical aspects of gold mining and metallurgy in the Transvaal, by Messrs. Hammond, Webb, Yeatman and Holmes in issues during 1898 and by Dr. Hatch in that for August, 1899. To these publications reference should be had for precise statements. Newspaper reports have been voluminous, in part illuminating, in part confusing. The purpose of the present paper is to supplement those of the well-informed authorities cited, by a more general consideration of the conditions from an outside point of view.

Historically, little need be said here; yet a rapid glance backward is not without interest. While the ocean route from western Europe

Cecil Rhodes, according to Mr. W. T. Stead, thinks it is the Supreme will that he should "paint as much of the map of Africa British red as possible, and * * * promote the unity and extend the influence of the English-speaking race." Whatever the immediate incident,

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ZULU WAR DANCE.

to the Orient by way of the Cape of Good Hope had long been of great importance, from the days of the early Portuguese, Dutch, and English navigators down to recent times (although latterly affected disadvantageously by the competition of the Suez-Canal route), little definite was known of South Africa to the outside world until quite recently, except what pertained to a mere fringe of coast and a few refuges and refitting points for shipping. True, the migration, in the sevententh century, of large numbers of Dutch settlers, with a sprinkling of French Huguenots who were impelled thither by a love of political and religious freedom, had brought in a sparse population which spread from the Cape gradually toward the interior. Later, on the general redistribution of territory following the Napoleonic wars in 1815, Great Britain, which had held, abandoned, and reannexed Cape Colony, came into possession of an additional tract of territory now known as Natal, but with indefinite boundaries to the north. A fresh influx of settlers then came in. Long after this the white population was still very scanty in proportion to the vast indeterminate area and to the numerous native races. All these earlier white settlers, though adventurous, hardy, and persistent, did little to develop the vast country, being engaged almost wholly in grazing and to a less degree in

the assured outcome of the present struggle will fulfill Mr. Rhodes' definition of his purpose; but the highest significance of the result will be economic, and not political. It will mean, first, an enormous impetus to industries already established when stable and equitable government replaces the rule of monopoly and repression. Next and greatest, it will mean the firm fixation and rapid on-moving of the greater scheme for a well-ordered, busy, prosperous, vastly-productive and vastly-consuming Anglo-Saxon empire on the erstwhile "Dark Continent." No one who is engaged in supplying the world with the tools of industry and progress can be less than absorbingly interested in the situation and its outcome. THE EDITORS.

agriculture of a primitive order—pursuits very useful and necessary, but hardly progressive.

Almost from the outset of the British occupation of Cape Colony there was friction between the two main classes of settlers, who, though distinctly of the same generic stock, failed to assimilate in the friendly manner of the Dutch and English in the settlement of New Amsterdam, called New York after the transfer. The Boers have always claimed, and honestly believed, that they were oppressed; which assertion impartial history cannot be said to have sustained. Great Britain, at least for more than a century, and also at least as regards her white subjects, has been scrupulously careful in dealing with colonial affairs. In this instance, one grievance seems to have been as to the abolition of slavery, which was suppressed at about the same period in the British West Indies on a similar adjustment. The Boers, however, were incensed on not receiving compensation satisfactory to them. This, combined with many other and pre-existing causes, real and imaginary—(such as extreme love of personal and national independence, racial antipathy, divergent customs and ways of thought) led to the further dispersion of the Boers northward, and, about sixty years ago, to the great trek into the then almost unknown desert. In this wilderness were established the Orange Free State and the Transvaal, more correctly called the South African Republic. The relations between these republics (especially the last named) and Great Britain have been at times more than strained, as witness the first Boer war in 1881. However, the differences were patched up after a fashion in 1884, partly on account of trouble with the Zulus, and the frontier was delimited, so that for a time the outlook seemed peaceful enough.

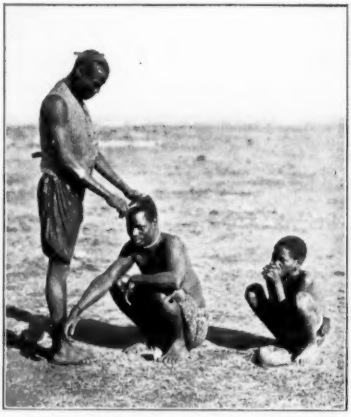
THE VELDT NEAR KIMBERLEY. THE COUNTRY AS THE BOERS FOUND IT.

WITCH DOCTORS

the new order of things. It led to an immediate inrush of adventurers, mainly British. In itself it was not a source of instant trouble, for the number of whites for whom there was no employment in the diamond workings and in subsidiary occupations was limited. But the pushing newcomers—at first the overplus of those disappointed in the diamond fields, reinforced by others who had there succeeded and had means to undertake fresh enterprises—began to spread over neighboring Boer territory. Meanwhile gold discoveries, of both placers and lodes, had been made in various localities of South Africa. These, while not largely productive as measured by the great outputs of more favored districts, were sufficiently promising to attract large numbers of prospectors who began to over-

A CAPE CART.

The much debated, misty and intangible question of suzerainty need not have created difficulties; the boundaries were clearly defined, and the Boers were left to themselves to work out their own evolution. This state of affairs might have continued indefinitely, or until the inevitable advance of the higher civilization should efface existing lines, had not entirely new and unforeseen industrial conditions arisen. The discovery of diamonds in Cape Colony and the Orange Free State marked one stage in



A NATIVE BARBER.

THE MARKET PLACE, KIMBERLEY.

"BETWEEN THE CHAINS." A JOHANNESBURG STREET SCENE.

A large amount of the trading in mining stocks is done on the street, and a section of this particular street is enclosed with chains during certain hours of the day.

run well nigh the whole of South Africa, including the two Boer republics.

As some one has put it, this was the irony of fate—that finally, after all the toil and danger and abnegation, they should have been led to the region most alluring to the cupidity of the hated Uitlander. The realization of this did not come at once and as a shock, but by degrees. It was not until 1885 that gold-bearing conglomerate beds of the Witwatersrand, in the Transvaal, were discovered, and it was not until some time later that the almost fabulous richness of the region was fully appreciated. At first, restrictive and prohibitory laws were enforced against prospecting for and mining gold. Then, when

PREMIER OPEN DIAMOND MINE.

it seemed hopeless to stave off the inevitable, and in the endeavor to make the best of the situation, a reversal of policy ensued. The Transvaal government saw the opportunity to replenish its empty treasury by means of taxing gold mining, directly and indirectly, and even went so far as to offer a bonus for the discovery of paying gold deposits. In Mr. Hammond's opinion this latter move acted as an immediate incentive to prospectors and was an efficient factor in the rapid growth, not only of the revenue, but of gold mining and its allied industries. Sooner or later, discoveries were bound to come; but it is worthy of note that the Transvaal government itself encouraged them and thereby tacitly but impliedly entered upon obligations which

no amount of argument can disguise. This feature is neither admitted nor recognized generally—certainly not by the Boers themselves.

At the same time it is possible—though the point is not altogether clear—that the Transvaal authorities expected not only to augment their revenues, but also, by taxing gold mining up to the limit which it could bear, to frame a double-acting policy which should promote mining to a certain extent and there restrict it. Such an explanation would be in harmony with the shrewdness accredited to the Boer managers; yet it is a policy which has overreached itself. Prior to the outbreak of hostilities the gold output had been brought up to a rate of over $75,000,000 a year. This is much less than the possible annual yield which could be had in the near future and could be maintained for a long period. The exactions imposed were such as to retard natural development. While investors stood ready to extend greatly the workings and to increase plant, the political uncertainties and doubt as to the financial policy of the South African Republic and its posture towards the mines have deterred them; so that, although there was a prospect of a substantial addition to productive capacity

PANORAMA OF JOHANNESBURG IN 1895. THE POSITION OF SOME OF THE PRINCIPAL MINES IS INDICATED BY THE NAMES ABOVE.

by opening new ground and adding to the mill plant, progress has not been what it might. On the other hand, the Government has not profited as it should. The indirect taxation through the medium of authorized monopolies has brought to the State exchequer but a small part of the total imposts, the remainder going to the favored corporations. But more important still, the Government income has been largely diverted from needed internal improvements to disproportionate armament, which would have been wholly unnecessary had not the Government unwisely provoked the resentment of the Uitlanders, whose efforts to effect a change in their favor became a menace from

A GROUP OF KAFFIRS—THE ABORIGINES AND PRESENT NATIVE LABOR OF SOUTH AFRICA.

within and also involved outside intervention from the Power whose subjects were most nearly affected.

A superficial view satisfies many. On the surface the Boer argument seems conclusive. It has often been expressed in varying phrase, and may be thus summarized: The Boer says in effect to the Uitlander, "This is our country; we settled it. These mines are in our territory, subject to our regulation. If you don't like our customs and our laws, why do you come here or why don't you get out? At all events your properties have flourished. Further, as to this franchise controversy, we do not believe you mean to become real Afrikanders; you only want to run things to suit yourselves."

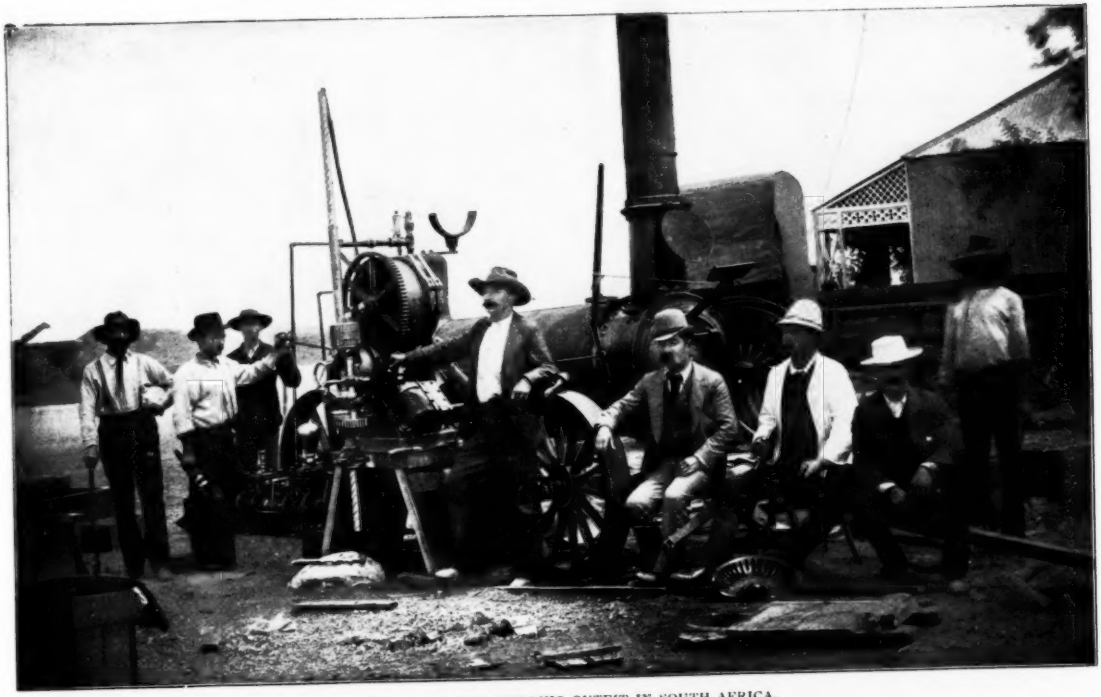
PAUL KRÜGER.

Of course it would be casuistry to deny the first proposition; for to assert that the land belonged to the Kaffirs would be about the same thing as to say that the United States, Canada, the whole New World and all colonized or conquered countries are held under no valid title but belong to the aborigines. Nor, unless modern ideas are at fault, will it do to assume the "Know Nothing" doctrine to be right, and to defend the alternative oppression or exclusion of aliens. No country rightly claiming to be civilized now maintains a system like that of the Boers. As to mining, the laws of different countries vary, but their aim is more or less liberal, not repressive, the restriction being such only as to ensure orderly regulation and the definition of titles, the usually light imposts being incidental rather than for the extortion of revenue. But in the Transvaal this one industry has had to bear nearly the entire burden of taxation, directly or indirectly. Furthermore, while it is true that the Boers were the original white settlers, the development of their country, except in the crudest form, has been due to Uitlander enterprise and intelligence. It is the mining and all the other industries necessary to and dependent upon mining, which have converted a once uninviting land into a highly prosperous one. Would the Boers have found, opened and developed the mines and established all the other now productive avocations? Once their land barely sustained them and its imports were insignificant. Now it is, except for war, most flourishing, with the promise of indefinite advancement. With material progress the opportunity arises for education, culture, and broadening of ideas. Isolated and stationary, the country's outlook would have been far different. Surely all this imposes obligations.

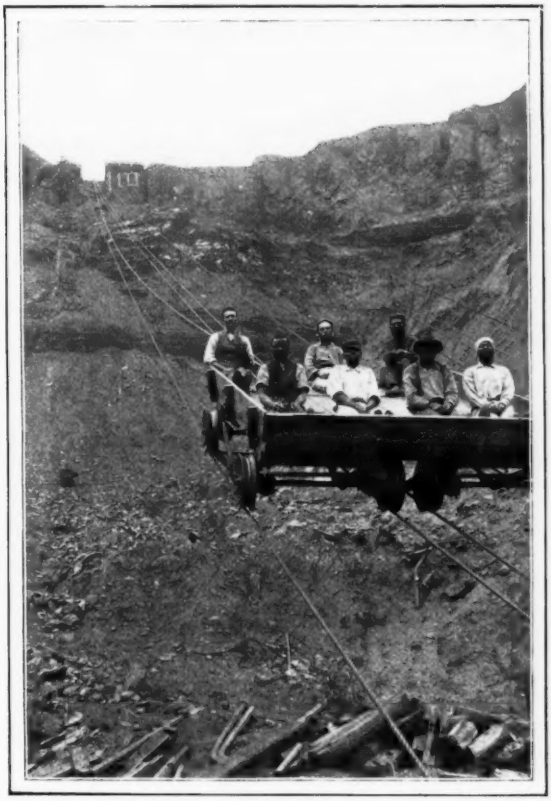
A HAMMER BOY IN THE STOPE.
Simmer & Jack Mine, Johannesburg.

The Orange Free State had no very direct interest in recent controversies. Its relations with Great Britain, outwardly at least, were amicable and might so have continued. But the fear of the Free State burghers that their country would follow the Transvaal, if the latter were absorbed, led them to join hands with their neighbors.

A REPRESENTATIVE SHIFT AT A SOUTH AFRICAN MINE EMPLOYING ABOUT 5,000 NATIVES.



A PIONEER DIAMOND-DRILLING OUTFIT IN SOUTH AFRICA.
The type of apparatus which has reduced the exploitation of ore deposits to a certainty.



KIMBERLEY DIAMOND MINE, 1899.
An investigating party going down into the old workings

The "black danger" is always an unknown quantity, but the native races have not favored the Boers, against whom they have many an ancient grudge. Thus far they have been apparently quiet.

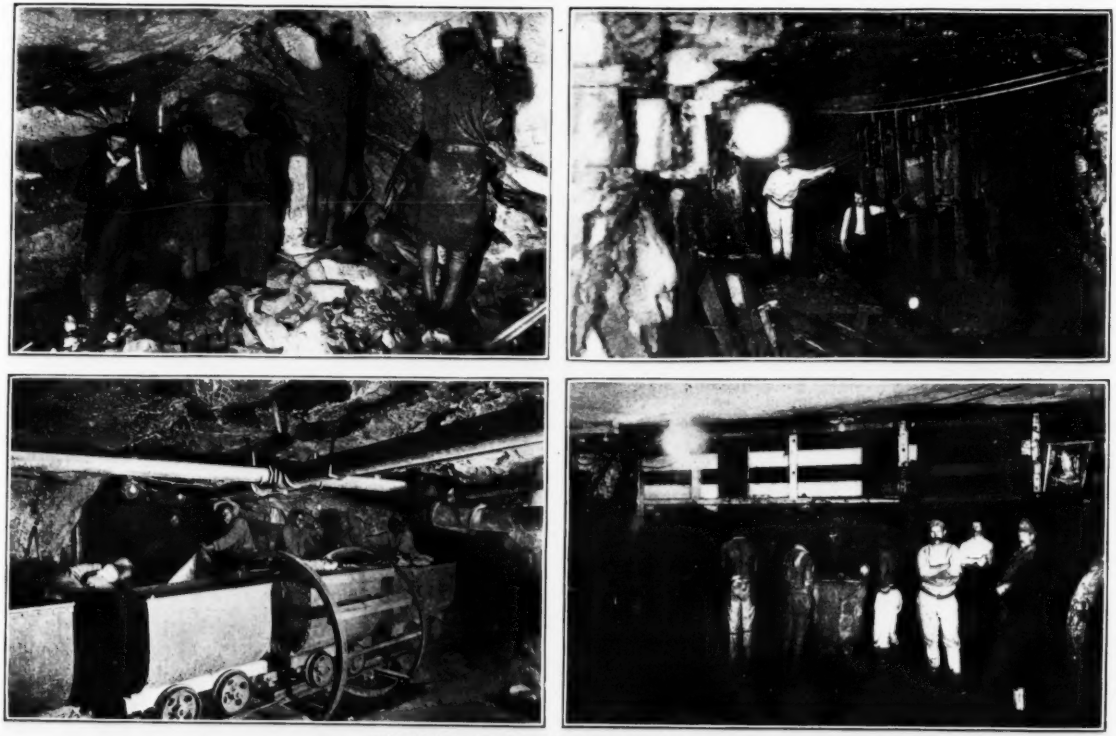
Before considering the interests of the great world, it may be well to refer to the position of the Americans now or lately occupied in the disturbed territory. As is well known, the engineers and metallurgists who have done so much to develop South Africa are in large number Americans. Most of them were employed in executive or consulting capacities. Very few are owners of property; they were for the most part working on salaries. With the closing of the mines these men,

who would be neutral on purely political questions, are sufferers. Their interests fall in with those of the other Outlanders, and naturally, also, with those of the English capitalists, their employers and associates. Yet, notwithstanding any bias arising from personal interest, and making all allowance for human fallability, it is well to note that their opinion is concurrent and decidedly against Boer methods. Men of this stamp, who can always find profitable occupation at home or elsewhere, are entitled to credit. It will not do to denounce their opinions as those of mere sordid speculators and adventurers. What these opinions are is well known. Perhaps if they had not come into

A REPRESENTATIVE SOUTH AFRICAN MINE. THE ROBINSON.

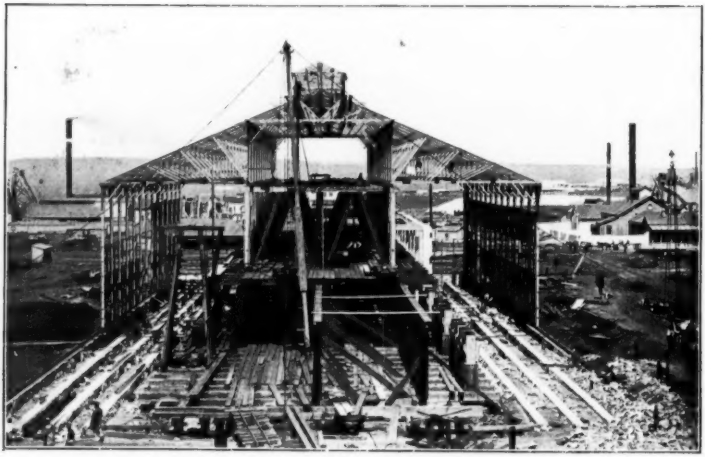
personal contact with the Boer system, and had had no direct experience and no opportunity for observation, they, too, might join with the unthinking at home. They have found it less easy to sympathize with the Boer at close quarters than at a distance.

Passing now from a consideration of single nations or groups of nations it is pertinent to inquire what is the material interest of the world as a whole in this South African question. Evidently, as a dictum of common sense in economics, it is for the interest of all to develop to the utmost the resources of a part. In this case these resources, so far as now known, consist, first, in the gold mines of the



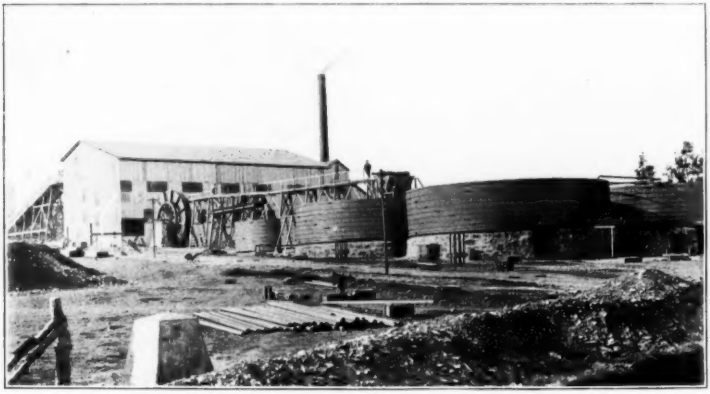
UNDERGROUND IN THE SOUTH AFRICAN MINES.

The two views on the left are in the Simmer & Jack proprietary mines; the two on the right are in the 1,000-foot level, Kimberley.



A TYPICAL STAMP MILL IN COURSE OF ERECTION ON THE RAND.
This battery is at the Simmer & Jack mines, and is the largest in the world, containing 280 stamps.

Transvaal, and, in less degree, in the gold mines of contiguous territories. Next in permanent importance perhaps might be ranked the coal deposits, originally opened to assist in gold getting, but later worked for supplying railway and steamship fuel and for general purposes, and promising to add largely to the welfare and advancement of a vast area, where timber is scarce. Northern Natal has been prominent in coal production, but the workable beds are widespread. The



AN AFRICAN CYANIDE PLANT. THE WOLHUTER WORKS.

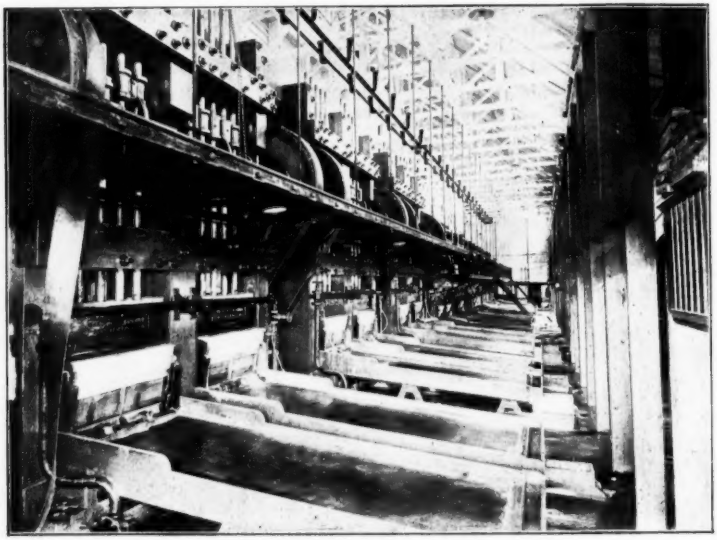
diamond mines, so important commercially, so profitable and so fascinating to prospectors and investors, must not be forgotten, for their future is also at stake, though apart from the central dispute. Then there are the railways, telegraph and telephone lines, power and lighting plants, and all the purveyors of supplies to the mines and miners. In the aggregate the present investment and "turnover" of all these allied industries is immense; but their future importance will be far greater. In their exploitation, the whole world has a stake. Whatever hinders or weakens this advancement is a positive loss to civilization.

The gold mines of the Rand alone had produced some 19,000,000

HEADWORKS OF A RAND MINE.
Steel headgear at No. 2 shaft, Robinson Deep.

ounces up to the outbreak of the war. However they may be retarded for the time being, their future is assured. Even if surface plant should be destroyed and workings flooded or filled in, the ground will still be there. Estimates of the total gold still remaining and available are necessarily not very reliable, but conservative engineers have placed the figure at about £600,000,000 ($3,000,000,000). All gold deposits vary in size and in richness at different points. The most regular are more or less spotted with zones or patches and chutes of pay ore and with spaces of barren ground or of ore of grade too low to be workable. In the case of the Rand reefs, however, there is a nearer

approach to regularity than is often found in districts of minor importance—certainly nearer than in any gold region of large area and consequence. The conglomerate beds are about as uniform in thick-



A STAMP MILL ON THE RAND

ness as most other stratified deposits, and they are very persistent. From the main outcrop the beds dip at first steeply, but in depth the dip flattens somewhat and is expected to carry the beds to a not inaccessible depth over a very large area. The lines of "deep-level" shafts and prospecting boreholes furnish evidence of this. The whole series of rocks form a wide syncline, the outcrops being on one edge. There are faults in places, but these are becoming better understood as workings advance. The syncline may be basin shaped or an oval depression, or it may turn out to have a longer axis than known at present. The depth to which mining may be prosecuted on the Rand is very great, as the temperature-increase is slight and water gives less trouble than in most mining districts. Under such favorable conditions it is possible to go down perhaps to 10,000 feet vertically from the surface. A few years ago it was thought that 6,000 feet would be the limit, but the deep shafts of the Lake Superior copper mines have proved that the mechanical limit is much farther down. Vertical electric railways, or cable hoisting in relays, with electric-power transmission to the lower hoists, will obviate the former disadvantage of the

great weight of long cables as compared with live load, and the danger of such cables breaking from their own weight. Similarly, pumping can be done from an indefinite depth by electric power. The question of very deep mining hinges rather upon the financial than upon the engineering question. The cost of the heavy plant to operate a deep shaft is very heavy; so also is that of sinking the shaft; and that of operating the mine when the ore is reached is of course greater than in shallower workings. Another item is the loss of time during the preliminary dead work of sinking, etc., which means the locking up of large capital and the loss of interest. But if ore of satisfactory grade and quantity is at the bottom, investors will be willing to advance all the money needed and to wait patiently for returns. Many mining enterprises have been successfully carried out which required very heavy investments and two years, or much more, of preliminary work. It all depends upon the ore and the assurance that it is there. Underground prospecting is becoming so reliable, as compared with former guesswork methods, that it is now often possible to plan very large mining enterprises with reasonable security and accuracy.

Dr. Hatch has gone over the subject of present mining expense on the Rand very thoroughly (in this Magazine for last August). It may be remarked, briefly, that in any event these costs will be con-

DEPOSITING FLOOR, DE BEERS DIAMOND MINES.

siderably reduced in the future. Under British rule the dynamite and railway monopolies would be suppressed, and thus two heavy items would be largely cut down. Labor expenses cannot, perhaps, be much

lowered, except by the introduction of a little more machinery, since it would be hard to reduce wages. Timber of good quality will always be scarce; some of the best has been shipped all the way from Oregon to African ports, thence over the long and costly railway haul to the mines. But, relatively speaking, the mines do not require very much timber. Altogether, and taking the removal of a large part of the taxation into the account, it will be seen that a large margin of reduction in mining costs may be looked for if the district comes under a liberal government, or if the Boers make concessions. The crushing and cyaniding costs have already been brought to a wonderfully close

THE KIMBERLEY DIAMOND MINES IN 1874, SHOWING THE ROPEWAYS.

figure, considering the conditions. In fine, a tenor of much less than 5 dwt. per ton will some day pay, if the ore is in sufficient quantity.

The total life of the Rand mines will depend, of course, upon a number of conditions—especially upon the rapidity of exploitation—and various estimates have been prepared. What can reasonably be calculated on, from fairly reliable data, is a duration sufficient to warrant as permanent investment as is prudent in any mining undertakings. Besides the series of Rand reefs there are many other known gold-bearing deposits in South Africa, both within Boer territory and in British ground. Some of these are already producing large amounts,

and others are promising. So far, nothing to equal the central group of the Rand mines has been found; but there are indefinite possibilities. As so much of the country is gently-rolling, covered with the heavy overburden of the veldt, there may be an indefinite number of blind ledges yet to be uncovered. The area is so vast, however, that outcrops in more rugged and bare localities escape observation by the few prospectors. Placers are more easily found, and have been worked on a moderate scale for some time.

It is evident that there will be room for a large extension of gold mining after existing troubles are over. The country does not hold

THE KIMBERLEY DIAMOND MINES IN 1899. THE WORKINGS ARE NOW UNDERGROUND ONLY.

out very alluring inducements to the poor settler, and unskilled white labor is at a great disadvantage in competition with the cheap Kaffir labor. But for judicious investment there will be great opportunities, which will be grasped by capitalists who are dissatisfied with the low interest and low returns from manufactures, transportation enterprises, etc., in older countries.

Another point suggests itself. So long as gold is the recognized standard of values by the leading commercial nations, the supply of the metal becomes of great monetary importance. The assurance of a regular and large output from the most important gold-mining dis-

trict known will remove fears of a shortage of coin money. The coming supply, though surely large, does not, however, threaten to unsettle values by overproduction, which was feared in the early days of the Californian and Australian gold excitements.

Diamond mining stands somewhat by itself, but has been handicapped in somewhat the same manner as gold mining, if in less degree. The industry is a most important one and has been very productive, with a long future still before it. A reduction in cost of transportation, supplies, and general charges will cut down mining expenses, though there may not be the same margin as in the case of the gold mines.

The same remark applies to coal mining. This industry has an assured future, apart from the market for the product at the other mines. The high transportation charges have affected coal mining, both as to supplies and as to the marketing of the product, and there are other items which will admit of betterment. The coal mines in British territory, of course, were free from certain exactions which would have been placed on them if under Boer laws, but there is room for improved conditions.

The number of persons who have a direct and tangible stake in the fortunes of South Africa is increasing, and their interest is most keen. All the world is watching with eager attention the march of events, military and political, in that far-distant theater of action; but all the world does not realize how serious is its less obvious indirect interest in the welfare of the territory in question. It is, perhaps unknowingly, witnessing the working out of one of the most impressive evolutionary changes in economics as well as in politics.

For illustrations accompanying this paper we are indebted to the courtesy of the Rand Drill Co., the Gates Iron Works, the Ingersoll-Sergeant Drill Co., the M. C. Bullock Mfg Co., Messrs. Fraser & Chalmers and Mr Geo H Sampson

THE VAAL RIVER AT BARCLAY WEST.

STRENGTH AND WEAKNESS OF THE TRUST IDEA.*

By John Graham Brooks.

"The first object ought to be to insure, so far as practicable, that the public should be afforded all such information as would affect the reasonable judgment of a man in determining whether he would or would not invest in a particular concern; and the next object ought to be that all holding fiduciary or quasi-fiduciary positions should be bound to disclose fully and clearly any interest which they possess differing from the interests of the other shareholders—in other words, that the transactions should be open and above board, and all the parties dealing on equal terms."—*Lord Chief Justice Russell, commenting upon the Hooley disclosures.*

IT may seem fantastic to quote Emerson on the subject of commercial changes but, as Tyndall found many a scientific hint in the pages of this seer, so we may find in him many an illuminating comment on industrial events. Note for example this: "Wealth is the application of mind to nature; and the art of getting rich consists not in industry, much less in saving, but in a better order, in timeliness, in being at the right spot."

I do not know in economic literature a truer word upon the significance and the necessity of business organization than these words contain. "Better order," "timeliness," "being at the right spot." Here is the very heart of the new organization if we consider it apart from its abuses. It is not merely to the new importance of location and organization, as commonly understood, that Emerson calls attention, but even more to the mental processes that gain in value at every stage in industrial evolution. This penetrating observation helps us to realize the relation between organizing thought and the external machine which thinking creates. The locomotive was a mere record of the inventor's mind, but to organize the railroad system of the United States requires the same kind of thinking, only upon a much higher plane. Every event that has widened the world's market has made a new machinery of organization vitally necessary. The organization of the Sugar Trust is an invention in the same sense that the new machinery for refining is an invention. When competition has reached a

* To persist in the use of the word "trust," long after it has lost its original meaning, may seem to be without excuse, yet the new terminology for the larger corporations that have come to the front is so ill-defined and so cumbersome that it seems better to retain the word.

certain desperate pitch among separate businesses within the same industry, a new task for the inventor has become a necessity. No analogy is probably so fit as that of the railroad. Here is our greatest and most powerful machine. All now admit that a perfectly free competition among these competing roads resulted in disaster; disaster to the stockholders and, in the long run, disaster to the public. When that period was reached, no remedy was possible except that which the inventor could command. To organize the conflicting roads into some harmony of action was an invention as strictly as any that the Patent Office holds. I have heard it said by a railroad president of large experience: "The next great step is one purely of organization. Our difficulty is to find the ability equal to the task." The ability, when it comes, will be, however, the ability of the inventor and the reorganization desired will be accurately analogous to the cunning which thinks out any lesser mechanism. The old machine merely put separate tools together into new relations. But it is still mechanism and invention to organize separate businesses to meet the conditions which a world market imposes. In this larger market the isolated business has become (in the instances we are now considering) like the separate tool. Where competition has brought confusion, the separate agencies have now to be united. This is the work of the new organizations. But the question must be faced: Has competition reached this frantic pass? Of course it has not reached it over anything like the whole industrial field. It appears to have been reached in some industries—like soft-coal production—where neither knowledge nor the proper agencies for organization are under our control. That it has been reached in other specific fields, where trusts are now appearing, is susceptible of the most convincing proof.

The evidence upon this point has an importance so great and so immediate that it should be given in specific form and be taken from those who speak from experience and with the least possible bias. First-rate men of business should, therefore, tell their own story. The discussion of the Trust is now developed so far, that the general ground of advantages and disadvantages cannot be covered in a short article. I therefore select, for chief emphasis, the state of competition in certain parts of industry which makes it impossible any longer to do business wisely and profitably through small and unrelated concerns. From a vast amount of proof, I take the following instances:

So competent an authority as Mr. F. B. Thurber said before the Industrial Commission about the grocers: "Competition in the distribution of sugar became some time ago so intense in the grocery trade

that the dealers were distributing it, not only without profit, but for less than the actual cost of doing the work. So the grocers got together—they have always been more or less associated—and asked the American Sugar Refining Company to assist them in securing a fair reward for the work they were doing. It was pointed out that it would be to the interest of the company to have the trade in a solvent, rather than an insolvent, condition and they were asked to make an arrangement, fixing the price at which the grocers should sell, and providing for a commission or rebate to them for doing the business. They hung off for a year or more, and it was only when the margin of profit was absolutely wiped out that the grocers, by keeping after them, finally succeeded in securing such an arrangement. Immediately some of the newspapers came out with the charge that there had been a great grocers' trust formed in the interest of the American Sugar Refining Company; whereas, the truth is, the grocers had had the hardest possible job to talk them into making the 'factor system,' as it is called. Even now it costs the average grocer, I think, about 4½ per cent. to do business, and he does not get more than about 4 per cent. in the distribution of sugar."

From some careful study of the soft-coal industry in the United States, I believe it within the mark to say that its condition, as respects free competition, is even worse. We have been deceived by the fine talk about "perfect organization" because this perfection applied to the separate individual concerns. But perfect organization in a separate mill, factory, or mine does not in the least meet the exigencies of a widening market that are now forced upon the trade. The general chaos that free competition had brought upon industries that are here considered cannot be seen if the eye is directed chiefly to the single business, but only as we look at the whole group of firms or corporations, and note *the relation in which they stand to each other.* The manner in which they have come to fight each other—the wasteful and sorry devices to which they are driven—give us the only true measure to the facts.

Socialist writers who have merely railed at competition, while they have often stated the fact, have not given us the most telling details. I have heard one of the most successful business men in the eastern States say, "If people generally knew how stupidly and wastefully much of the large business is carried on, we business men should become objects of ridicule." The able chairman of the Interstate Commerce Commission has recently characterized American railroad management in the following terms:

"I undertake to say that if the worst enemy of the railroads whom

you can name were elected President of the United States, and if he should pack the Interstate Commerce Commission with the worst Populists of the land, those men would never dare to do the reckless and indecent things which the managers of railroads themselves have done. Can you name any five men so ignorant, so prejudiced, so inimical to the common interests of the country that they would upset the commerce of the country and demoralize rates and business in the way the railroad men have done by putting in force the rates that now prevail to the seaboard by way of Galveston and Missouri River? Would they let the Missouri River rate be as low as the Chicago rate? Would they allow flour to be carried from Minneapolis to the Atlantic cheaper than from Chicago? In such things the railroads are making a fearful misuse of their power." This puts no slander upon the intelligence of the managers. It shows rather the pass to which an unregulated competition has brought things in this great industry.

What boasting there has been about the marvels of organization in insurance! Yet I have heard from one of the foremost men in that business this criticism: "It would not be safe to have it known how badly and how extravagantly things are managed over the whole competing field." I asked a very prominent insurance man of the middle western States if this were a fair statement, and he replied: "I should state it, if I could, in much more vigorous English. Competition has got us now where the only dress that we ought to wear is the cap and the bells." Even if it be maintained that there is some exaggeration in these strictures, the main fact cannot be contested.

Now it is only upon this background that the need of the new organization of business can be fitly studied. No argument appears to weigh more with thoughtful men, who fear these combinations, than that "they will destroy the independence of thousands of small business men." The slightest study in detail of the areas we are considering shows that competition was already raising havoc with this same class. What does the "proud independence" of a small owner of a soft-coal mine signify? What did "independence" mean for the corresponding man in the hard-coal industry before it was brought under a powerful combination? Wherever competition has developed into such excess, as in the above industries, it is grotesque to talk about "independence of the small middle class."

So far then as the business men above quoted have told us the truth, I submit that the time is already at hand for some kind of wide, effective, and thorough re-organization. Nor do I believe it open to doubt that the immense pressure of this necessity is producing the so-

called Trust. Men will fight it as they fought machinery and with precisely the same results. At least fifteen years of hostile legislation should have made it clear to the dullest man that the greater massing and ordering of capital cannot be stopped. It may be annoyed. It may be forced to change its methods or place of business, but what is essential to the new process has not been checked in the least. The reason for this is that forces far more powerful than legislative action are behind this movement. In many trades it is at least possible to overstock the market in seven or eight months of work at full speed. This fact is revolutionary in its significance. It means that the time has come for conscious and calculated adaptation of the product to the market. Now the small business is helpless to make any such adaptation. A powerful combination can do it, so far as to steady every process both for capital and for labor. Every attempt to check this new necessity is as idle as it is obtuse.

Texas and Missouri may exclude trusts, but with what results? The products will be produced elsewhere and the goods be taken back to be sold in those States by agents. When the working people of those States find this out, are they likely to take kindly to this exclusion of work from their midst? Not unless they differ from the workingmen elsewhere. The most intelligent and powerfully organized unions, as among the iron and steel workers, already show the most positive signs of welcoming the Trust as likely to give them a larger and surer opportunity of identifying their group interests with the interests of the industry. Only those who represented the decaying order of the Knights of Labor at the Chicago Conference* showed the slightest hostility to the new combinations. Men who stood in the closest relation to iron and steel unions reported their members as more and more convinced that the industrial reorganization marked a favorable epoch for organized labor. "Many of our men are already taking the preferred stock in the new combines," said the former president of the Iron and Steel Workers. This declared purpose of many of the strongest unions to favor the Trust springs from the belief that it will be easier to cope with a highly centralized power than with scattered employers. Many a strike has been checkmated by the aid, (as by filling orders), which other employers have given to the one whose men were out. It is now claimed by the unions that they can act as a unit against a single organization. Their long experience of the importance of having public opinion upon their side also accounts for much of this approval of trusts. They feel with much justification

* The National Trust Conference held at Chicago during October is here referred to.

that, when the issues come fairly before the people, public opinion will not allow all the advantages of organization to go to the men at the top. It will seem but fair to insist that the entire group within the industry—employers and laborers alike—have the same privileges that organization gives. Another result sure to follow is the pressure which the larger organization is certain to put upon the trade union. Its constant weakness has been the lack of cautious and able leadership. It is already seen that the Trust brings the ablest men in the industry to the front as managers. The same is likely in the long run to prove true of the unions.

It is, of course, true that the present is no time for final judgments upon any of these questions. The high tide of prosperity that now favors the United States can float the craziest crafts. Only at the ebb will the test come. Even if the shallows are strewn with wrecks it will not prove that the Trust is at an end. It will only repeat what American railroads have to a large extent already passed through. Beyond and deeper than all these failures, crazy schemes, and wildest gambling, are the uses and the necessity of an ever wider and more thorough organization. For many of the great industries the same need of regrouping is at hand, and the one test of intelligence is to distinguish clearly between the uses of the new order, that we cannot longer forego, and the abuses that shadow every step of civilization; abuses that must be fought as abuses, and not as inherent or structurally necessary to the industrial transformation.

The question then presses; even if reorganization has become a necessity; even if enormous economies will result from the new order; even if production can be adapted to the market, business steadied through the year and the laborer kept more evenly at his work—what of the open and certain evils that affront not only our morals but our intelligence? I shall say little of the fear that just now seems to be most popular—"over-capitalization"—because what is most dangerous in this to the community at large may be met by publicity. Indeed, most of the evils will be found to centre in the underhand methods which no civilized nation, except the United States, any longer permits. The rank abuse of special rates by railroads is also a part of the same corrupting methods. It may be taken as a certainty that a large number of these enterprises will go to pieces. Scores of attempts are now making among industries in which the limits of free competition are by no means reached. Others are over-capitalized to such an extent that the first prolonged strain that is put upon them will bring disaster. It is to be hoped that the end will come for these more reck-

less ventures before the shadow of the next business decline falls upon the country. To squeeze the water from any large number of these concerns in quick succession would mean a danger of the first importance. Of tariff privileges to these combinations, inexcusable as they are, it may, I think, be confidently predicted that public opinion from every quarter will rise up against them.

Let us turn then to the foremost danger. To deal with it adequately would require far sharper distinctions between the economic and the political elements than is possible in this article.

The dominating peril of the trust—the peril that includes most others—is the influence of the large corporations upon politics and the bearing this influence has upon economic privileges. The part that certain corporations have played in corrupting the sources of political life in the United States is quite the gravest danger under which the country suffers. I have never heard so drastic a statement of this fact from the wildest Socialist, as I have heard a score of times from the very men who do these things. The new combinations add four-fold —ten-fold—to their power. What, then, shall keep them from the old tricks on a far greater scale? I put this question recently to the manager of one of the strongest combinations in the United States. His answer contains, I believe, what will prove true of those combinations that survive, let us say, the next business depression. He said: "In concerns so concentrated and so powerful as the new combinations, the old secrecy will have to go. We shall be too easy a target for a hostile public opinion. We shall be driven, in self-defence, to methods that will bear the light." No feature of this whole movement is more hopeful than that which these words imply. The immense changes which the vaster organization carries with it are almost certain to force, for the first time in American industrial life, far greater publicity of business procedure. Before dealing with this chief "remedy," it should be said that the old distinction, of which we now make so much, between public, semi-public, and private corporations is sure to be profoundly modified by trust development. Mere magnitude of industrial operations in the products of common necessity will convince the public more and more that iron, hard coal, sugar, and the like, may pass into semi-monopolistic control so widely and so delicately related to the public needs that the term "private corporation" can no longer apply to them. It has long been said, "Iron is the basis of our material civilization." Is it then to be questioned that a common necessity of life, controlled under unitary management to the extent of seven or eight hundred mil-

lions of dollars, is not, in a quite new sense, public business as well as private? Publicity is, therefore, not only the first of remedies but one that is certain to be enforced. The evils of corporate secrecy are strictly comparable to the other evils of competition, which have just been considered. When competition reaches its cut-throat stage, secrecy takes on a far more dangerous character.

One advantage of the rising agitation is that the important facts in regard to stockkholders' rights are for the first time being brought clearly before the public. Thanks to Delaware and West Virginia, where the furor to attract corporate capital has gone to greatest length, the public is certain to know both the abuses of secrecy and the present conflict between existing law and the investors' rights. These States permit stockholders' meetings to be held wherever those who control the corporation may elect to have them. The same free and irresponsible use of the books is also allowed. Authentic instances are reported in which the stockholder hunted in vain to find where the books were kept. English law gives the stockholder the right to demand whatever information concerns his interests as an associate in the corporation.*

Two able investigators of trusts† who visited the United States to make careful personal inquiry were amazed to find how little had been done legally to assure the stockholders those elemental rights which publicity affords. Dr. Von Halle says in his book: "It is one of the most disastrous holes in the corporation law of the United States that stock companies are not forbidden to buy or sell their own securities. In Europe such transactions have been punishable for many years." No one, indeed, is saying these things with more emphasis than the able men who make or manage the trusts. In his statement before the conference at Chicago, A. F. Hatch spoke thus: "Stockholders should have access to the books and records of the corporation at all reasonable times, and should have the power to compel disclosure of all information necessary for the protection of their interests. All corporations which appeal to public support by placing their stocks upon the public exchanges, thus inviting investment by the public in their securities, should give the greatest degree of publicity to their affairs. If the public are invited generally to invest in the securities of a corporation, the truthfulness of all representations made should be en-

* A bill now in Parliament is said to make it a penal offense to refuse the list of stockholders to anyone who may demand it.

† "Trusts or Industrial Combinations and Coalitions in the United States." By Prof. von Halle, University of Berlin, published by Macmillan. "Les Industries Monopolisées aux Etats-Unis," par Paul De Rousiers, Colin, Paris.

forced and the same degree of publicity to which the stockholder is entitled should be extended to the public."

This secrecy is, moreover, the fertile mother of another brood of ills. Secrecy makes it possible to organize both the opportunity and the temptation to play the industrial game with loaded dice. The itching to get something for nothing upon the market is at any time the master vice in trade. One risk of the business boom is always that it lets loose these reckless forces that hasten every disaster of the next business collapse. The new "combines," if they can manipulate clandestinely, easily fire every passion to play with stock variations—to lay traps for the unwary, to declare dividends that never have been earned, and to unload lying values upon the public. The forms that this gaming trickery may take are hundred-fold. Just now a stockholder in one of the better "trusts" tells me: "We have declared a dividend on the common stock, but I would lay a wager that it has not been earned. Whether it has or not is impossible to find out." Vicious as all this is, it would be as silly to lay the fault primarily at the doors of these corporations as to curse money because people will gamble with it. Yet it is evident that every form of secret control—every hidden device, as to methods of management—immensely overstimulates this dicer's spirit and therefore adds to the most dangerous uncertainties of business. A capitalization based on what one hopes for one's business—capitalizing mere bragging and conjectures—is what secrecy makes possible. That this evil can be greatly lessened has been proved not only by English experience—it has been clearly proved by Massachusetts experience. That State has already had many years' experience in controlling over-capitalization, not only in semi-public corporations, but in strictly private ones. The degree of publicity to which these corporations must now submit in Massachusetts is far greater than is commonly supposed, and has been attended by results so hopeful as to mark a sure way for further legislation. The recent testimony of the Hon. J. J. Meyers before the Industrial Commission will prove of value to the public upon this point. This experience, together with the experience of the Interstate Commerce Commission—in spite of all its failures—may well furnish a safe basis for such Federal action as shall give unity of procedure in different States. That such action upon the part of the general government swarms with difficulties means only that industrial growth now presents for solution a new set of problems.

Finally, the present condition of a score of these combinations brings out with startling clearness one hopeful fact. Nothing is more

to be feared in this movement than too rapid or too easy triumphs. Fortunately, these quick achievements are under the most wholesome check of finding an experienced ability equal to the tremendous tasks that suddenly enlarged organization imposes. Another phase of this fact is the loss, in the new grouping, of all that is meant by "good will." It will certainly require much time to offset this loss of direct personal interest, built perhaps from the beginning by the man himself, as it passes into a more impersonal and wider combination.

Between the capacity to run an average corporation and the capacity to run a corporation of five or ten times the magnitude, there is no calculable relation. Yet many of the trusts have to depend for their success on that very unknown quantity of talent. It cannot be extemporized nor made in a month or a year. It is an open secret that several trusts are at the present moment suffering keenly from this want of ability to match the exigencies of the reorganization. A group of corporations may have, among its managers, a man to match the new duties, but it requires time and repeated tests to be assured of this. It requires time to persuade other directors, who think well of themselves, to admit the superiority of another and yield to it. The masterful managers of the sugar and oil combinations came slowly and naturally to their positions; but what likelihood is there of extemporizing the new leadership for miscellaneous, quickly-formed "industrials"—whether of bicycles, leather, or woolens? I asked a man of experience why there was no combination in the print cloths. "Well," he said, "there are a dozen fat-salaried treasurers that have to be taken care of, which is difficulty enough; but a far greater is the entire uncertainty as to what one head is equal to the general direction. At least two very dangerous years would have to pass before we could find that out." This difficulty is not fatal. It will wreck many attempts, but reorganization will follow when time and conditions favor.

If the period of reorganization is upon us, the very necessity will create the strength to guide the movement. Men's wits do not greatly change from age to age, but mechanical aids to intelligence increase as by magic. The manager of one of the chief industries in Pennsylvania was asked what difference the telephone had made in his business. He replied: "If I may add the typewriter, I should say that the telephone enabled me to do at least five times as much business as formerly." The assured extension of these appliances in the future shows that time is likely to bring out the capacity equal to the new emergencies. This waiting period is, however, one of the most beneficent restraints, from every point of view.

WORKS MANAGEMENT FOR THE MAXIMUM OF PRODUCTION.

By J. Slater Lewis.

III.—COMMERCIAL ASPECT OF THE PROBLEM OF NEW PROCESSES.

N approaching the "Problem of New Processes," care must be taken to pay due regard to practical considerations, as distinct in many ways from the theoretical and technical. I propose, therefore, in this article, to deal with a few points which, though some may appear to have little bearing upon the subject, are nevertheless of great importance to those who are studying the problem of new processes and other allied subjects.

There are, of course, limits to which mass-production, as an economic factor in the introduction of new processes, may go. It will be clear, for instance, that whilst bicycle makers, tool makers, engine builders, dynamo builders, and agricultural-implement makers may have their respective works equipped with special tools and appliances for turning out standard goods in large quantities, heavy and special machine-tool makers, ship-builders, makers of heavy rolling-mill and forging-plant, makers of rubber and cable machinery, bridge builders and such like, whose productions are few and special, and rarely, if ever, alike, cannot, for obvious reasons, follow suit. That is to say, that it would be an economic impossibility for them to equip their works with special tools for the production of large quantities. It is quite true that their works should be equipped with high-class tools suited to the general run of work in their shops. It is also true that their organisation and general facilities for handling their work should be thoroughly up-to-date. But to expect them to install specially large and costly machine tools for "handy men" to work, when perhaps hardly one of them would be employed an hour a day, would be nothing less than mechanical engineering gone mad. There is, therefore, a critical point in the successful working of every factory, where the principal or manager has to decide between making some of the parts of his machines with his own plant, and buying them from the outsider or specialist whose works are equipped for the manufacture of those parts in large quantities. Nor is it always a question of cost; it is more often a question of *time*. Take, for instance, the case of breakdowns and general repairs in connection with steamships and large factories. These often form work of the most

urgent character, taken in hand by specialists who make a point of turning out, say, large crankshafts and large gear-wheels within an amazingly short space of time. But they are more frequently handed over to the general engineer, whose works happen, perhaps, to be in the immediate locality in which the breakdowns occur. In these cases competition, except in the matter of *time*, rarely enters into the question, inasmuch as prompt execution of the work to be performed is of paramount importance. It will therefore be obvious to practical men that I must draw a fundamental distinction between the general engineer, who, in a sense, is called upon to do a bit of everything—and who will always be existent, however crude his plant—and the specialist who has "lines" of his own and will not depart from them.

But it may be well, before proceeding to the further consideration of the problem, to clear the air of the theoretical and technical claptrap which it is so fashionable to hash up for the edification of mechanical engineers. That the time has arrived when every manufacturer must be in as favourable a position for turning out his goods as cheaply and as efficiently as those with whom he is brought into competition, no one will deny; in fact, it is rather a question of their "going one better" than keeping abreast; but when those whose knowledge of the subject is only born of their own imagination begin to advise old-fashioned engineers, all and sundry, to pull down their barns and build greater ones, it is about time for them to pause and ask themselves whether life would be worth living under such volcanic conditions. It seems to be quite the "correct" thing nowadays for all "cranks" and would-be engineers to denounce everything that is not carried out on the vast scale now obtaining in some directions. They would fain ignore the evolutionary principles upon which commercial progress can alone be made, and would have the whole engineering world instantly turned into a gigantic show-room, despite the fact that there is not at the present moment a single engineer in Great Britain whose works are not taxed to their utmost capacity. It would be against human nature itself to expect old-time engineers to set about reorganising the whole of their establishments whilst they are extremely pressed with work and making money, and writers who suggest such things do a great deal more harm than good. They should try to realise the fact that to attack these knotty problems successfully it would be better to take the retrogressive engineer gently by the hand instead of forcibly by the throat.

It is no digression to state here that the principal causes for this present feverish state of mind seem to be the orders that were sent

to America for the Atbara bridge and the Midland Railway Company's locomotives. No regard for actual circumstances appears to have had any weight with the enthusiastic gentlemen who write so airily upon these vexed questions. It is with them a mere question of old shops and antediluvian tools and nothing else! But a few years ago, the mechanical engineers in the British Islands were suffering from a general stagnation of business; but what has happened? Why, almost without warning, a flood of trade came down upon them, and although large new works have been built, and many existing ones hurriedly and considerably extended, it has been found quite impossible to cope successfully with such an inrush of business. It is, of course, very easy to be clever after the event and to tell people that they should have been prepared to meet such a state of affairs.

Now, if we must treat the subject of maximum production upon sound business lines we must first throw aside all prejudices and then impartially investigate the why and the wherefore of things. Let us, therefore, consider one or two features wherein lie much food for reflection for those who regard foreign competition and the securing of these orders for bridges and locomotives as the death knell of British engineering, and who lay the blame almost wholly, not upon prices, nor upon an abnormal demand, but upon our defective organisations and the want of modern machine tools and works. Take the Atbara bridge first. We are told that no English bridge-builder could complete the work within the time specified. That has been regarded as a sign that British bridge-building is decaying for want of modern organisation and appliances. No mention whatever is made of the very important fact that, having due regard to the existing engagements of the English firms, prompt delivery was an utter impossibility. As the efficiency of British engineering firms has been arraigned in connection with this matter, I may be forgiven for pointing out a notable bridge-building incident which occurred in England about twenty years ago, when little regarding forced production was heard of. A large stone viaduct on the London & North Western Railway was swept away by an enormous flood. To have rebuilt the viaduct in masonry was out of the question, as every hour was of immense importance to the railway company. It was therefore decided to build an entirely new viaduct of steel. Drawings were at once prepared, the masonry piers built, the metal rolled. and the whole of the parts of the viaduct or bridge brought on to the site. erected, the lines relaid, and traffic resumed within one month of the date of the accident. Mr. Webb, the chief mechanical engineer of the

railway, might well be proud of such a skillful and unexampled feat, and it is quite a question whether the builders of the Atbara bridge, with all that we hear about their special and modern plant, could have accomplished the task within the same time.

Mr. Webb, of course, had behind him a powerful organisation, and all the material and tools that were necessary for the expeditious accomplishment of the work, and I presume the builders of the Soudanese bridge were similarly situated; but whether, regarded as commercial incidents, such forced productions as these undoubtedly were would be financially successful in the open market is altogether another question, unless of course, standard designs were accepted, obviating the necessity for new drawings. Practical men are therefore entirely oblivious to what may be done, for once in a way, by turning a shop inside out and upside down. These incidents are therefore of no commercial value to us whatever.

And now for the Midland locomotives. It seems to be unknown generally that the locomotive shops in Great Britain are, from whatever point of view the subject is approached, superior to anything of the kind to be found either on the continent of Europe or in America. Many of these shops were the first to adopt special machine tools for special purposes, and they have kept well abreast of the times. Works lighted by electricity, machines and cranes driven by multiphase electric plant, electric cranes serving individual tools, separate plant for making their own iron and steel castings and forgings—in short, provided with every known device for the saving of labour and the production of high-class goods—many of these shops are models of enterprise and good management. But, why, it may be asked, did these British locomotive builders allow these Midland orders to slip through their fingers and get into the hands of Americans? For the very simple reason that they had already in hand at least two years of solid work for their old British and foreign customers, and were, and are now, refusing orders at first-class prices right and left. This is, therefore, entirely a question of sound business policy on the part of the buyers of British locomotives. It is, in fact, only fair to assume that there is a distinct preference the whole world over for British machines, otherwise the American locomotive builders, with their special plant and consequently cheaper prices, would have secured a fair share of this extraordinary run of work ahead.

Sir Benjamin Browne points out, in the very able article which he contributed in the October number of this Magazine, that the consulting engineers of Great George Street have seriously injured the

locomotive trade of England by the capricious and fanciful notions which they insert in their specifications. Unfortunately this tendency is not confined to the locomotive industry. It is rapidly spreading to other industries, and it therefore becomes a physical impossibility for British engineers to standardise their goods and force production as is their wont. This unfortunate habit is of paramount importance to all British trades and is all the more serious since anything German or American will be gobbled up in the precise form in which it is offered! And if the subject of "Works Management for the Maximum of Production" is not to be stripped of its importance, and the attempts to standardise and force production to be rendered entirely ineffectual, the Westminster School will have to put their loyalty into practice, and place Britishers upon precisely the same footing as they do outsiders. Perhaps the mere fact that foreign consulting engineers, now having practices in London, are passing as many orders as they possibly can to foreign firms, may bring some of these gentlemen to their senses.

The whole of the foregoing questions have a direct and all-important bearing upon the subject of these articles. "Intensification of Output," or "Works Management for the Maximum of Production" means nothing less than a pitched battle for manufacturing supremacy. And, in order that we may rightly understand the strategic problems that we have to solve, it is a *sine qua non* that we start on a clear and equal basis, and not by dragging in side issues or trailing herrings right across the line of scent!

When we speak, therefore, of "Maximum Production," we mean the production of articles or commodities of given standards or excellence, at the lowest cost and yielding, of course, the highest profits. Unfortunately many large concerns, which believe in the gospel of standardisation and lay themselves out for producing lines of goods at mininmum rates, consider it to be a good business investment to sell them at ruinous prices until the little maker of similar goods has been crushed out of existence. Birmingham was the first city to immortalise itself by resorting to practices of that kind, and many a poor manufacturer remembers it to his cost. That sort of thing is now becoming quite fashionable, and if it goes on it will soon be *not* "the battle of the tools" but "the battle of the dollars." And if the dollars of one or two large firms are too few to warrant an attack of that kind upon the weaker fraternity, the "combine" comes to the rescue and by an organised effort it soon does the trick. We have seen great "combines" formed in England recently in connection with the cotton

industries and other trades, also in connection with the salt and chemical trades, and others are looming in the distance. These "combines" are not, however, always successful—the salt and chemical combines" to wit. Unfortunately for them, they had to contend with independent enterprises which being so rich—rich beyond the dreams of avarice almost—were in a position to withstand organised attacks, and once having weathered the storm, a steady golden harvest for them was inevitable. The profits of these independent concerns per unit of capital invested are to-day very high, whereas the profits of the salt and chemical "combines" are, on a similar line of reasoning, a minus quantity—due no doubt to the heavy cost of flotation, the fancy prices paid for rotten concerns, the heavy organisation expenses, and last, but not least, to the want of the more *distinct personal element of control* in the management of works that are scattered about in all parts of the country, instead of being, as they are in the other case, practically in one active and convenient centre.

It will be seen, therefore, that however formidable these "combines" may be, they may not always succeed in bringing all interested parties into line—and that those who can afford to stand aside and wait events may, owing to the fillip given to prices by the "combines," find themselves in a sort of manufacturing paradise, and be safe against further attack. "Combines" are, therefore, risky undertakings to invest in, and can only be regarded as absolutely invulnerable when they own or control the whole of the raw materials indispensable to the commodities for the sale of which they were established.*

It does not require a very extensive stretch of the imagination to enable one to see that there are no impregnable rocks upon which engineers may take their stand. The exigencies of competitive warfare are such that the specialist—he who carries all his eggs in one basket—may almost at any moment find the ground cut completely from under his feet. Necessity has always been the mother of invention. As soon as one specialist begins to reap the fruits of his enterprise, another comes along either with a better article at the same price, or with improved machinery that will enable him either to wipe out his antagonists or to compel them to run their businesses at a loss. The tortuous undercurrents in the sea of competition for standard commodities are, indeed, perplexing. Small wonder, therefore, that many capitalists should regard the single and narrow channels of specialised trades as questionable outlets for investment; in fact

* It is highly interesting, in this connection, to compare Mr. Brooks' discussion of the Trust (pp. 351-360) and the editorial on page 431 of this issue.

therein lies the principal security of the thoroughly well-established specialist, whose profits are not of such proportions as to excite the competitive spirit in others. I am, of course, excluding monopolies in the consideration of these questions—concerns whose manufactures are protected by patent rights. Mass production in the case of such monopolies is simple enough, though it frequently happens that the true element of enterprise is wanting in those instances where its free and full exercise might be applied with considerable and certain success. It is, nevertheless, well known that English patent laws, with all their uncertainties and intricacies, have a baneful and injurious effect upon trade, especially in connection with the operations of those manufacturers whose means are of slender proportions and who do not care to face the ordeal of law-suits which might land them in costs that would mean the entire wrecking of their businesses. Instances of the gross abuse of the British patent laws are more numerous than a healthy condition of affairs would permit. I know of "inventions" which have been rejected by the examining officials in the American and German patent offices which are nevertheless being "run" in Great Britain by wealthy corporations under the shelter of British patents. Monopolies are often set up in that way and maintained as the result of our inefficient and ineffective patent laws which not only have a detrimental effect upon mass production as it affects the manufacturers, but as it affects the general community. Chambers of commerce and other interested institutions would in consequence find solid and profitable employment in taking such steps as may be necessary to make British patent laws directly effective by affording inventors the advantage of searches that would put the stamp of genuineness upon their certificates of acceptance and thus prevent wealthy companies having exclusive privilege under what are in reality sham patents.

Without due regard to all these contingencies "Works Management for the Maximum of Production" would be nothing less than a delusion. People do not embark capital in trade for the mere fun of the thing, nor will owners of existing shops put all their old plant on the scrap heap, and replace it by new, unless there are very cogent financial reasons for doing so. In other words, engineers will not spend large sums of money in specialising, and thus relinquish much of their regular trade, unless they see good prospects of steady markets at prices that will in the end make the general financial result more satisfactory than it was previously. Shrewd men of business care little or nothing for the ravings of enthusiasts. They pre-

fer to take a general survey of things that are within their own knowledge, and if they have travelled and kept their eyes and ears open they will be in a position to gauge fairly accurately the probabilities of new enterprises as well as the benefits to be derived from the introduction of new processes of manufacture. Let me relate a case in point. A few years ago, an English firm in the iron trade—one of high repute and old standing—was gradually dying of that infirmity which is characteristic of old age. The new processes and smart methods of its rivals had almost killed it, when the son of the principal suggested that he should see what was being done in other countries. The suggestion was ridiculed at first, but in the end it was carried out, and it so thoroughly opened the eyes and sharpened the wits of the young fellow—himself a well-educated and capable man—that an immediate change in the firm's methods of manufacture was decided upon, and duly effected. The business gave prompt results of the most satisfactory character, and the firm is to-day again one of the wealthiest and most enterprising concerns in Great Britain. I know of other cases where "new blood," guided by an intelligent comprehension of facts and stimulated by a healthy desire to excel in enterprise, has wrought changes truly glaring in importance.

It must not be assumed from these criticisms that I am taking the part of a special pleader to the British engineer. I have merely considered a few of the side issues as essential elements in the solving of the commercial problem of new processes. I may, in fact, say right here that Britishers would be blind to their own interests if they were to ignore the excellent teachings and splendid business qualities of their Continental and Transatlantic friends. It would be highly imprudent and impolitic—nay, suicidal—for them to disregard "the writing on the wall." Whether we like it or not, and whether the ultimate end of all this specialisation and mass production be socialistic in tendency, or may lead to the death of the small man and the rearing up of the hoary head of capitalism or otherwise, the trend of the times is distinctly in the direction of a vigorous and determined struggle in which the men who are possessed of wide practical experience and implements of superior calibre will win.

In the next article, I shall first deal with the problems connected with Trades Unions and the guaranteeing of standard rates of wages, and with other subjects where circumstances in connection with these questions differentiate to an exceedingly important extent. I shall then conclude by a reference to the theoretical and technical questions underlying the subject of mass production.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

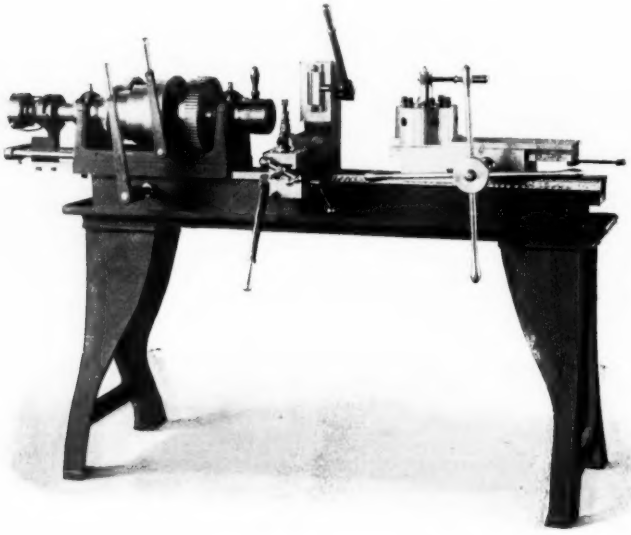
III.—APPLICATION OF THE TURRET TO GENERAL MACHINE-SHOP WORK.

WHILE the great reductions in time-cost of machine-part production, gained by the use of the turret carrying a number of fixed tools, were almost instantly recognized by manufacturers who produced large quantities of small parts in duplicate, and great numbers of turret lathes were placed in work as rapidly as they could be produced, it was long supposed that these tools had no field in the general machine shop, and that no advantage of their great time-saving possibilities could ever be taken in the construction of anything larger than small arms and sewing-machines, except in the case of valve work.

Among the early productions of the Windsor shops was a brass-working "Monitor" lathe in several large sizes, designed by Stone, specially adapted to finishing the bodies as well as the smaller parts of brass globe-valves in all common stock sizes. These machines had a production capacity from six to ten times that of the slide-rest brass-worker's lathes previously employed in valve finishing, and came into exclusive American use for valve working almost as soon as they were offered for sale.

Some of these early "Monitors," named after Ericsson's famous revolving-turret gun-boat, could handle work 12 ins. or more in diameter, either in brass or gray iron, and it seems strange that the great gains in large-valve making effected by the use of fixed tools carried by the turret should not have immediately forced the turret into general machine-shop use. Such was not the case, however; although the use of the monitor in valve making was firmly established as early as 1862 or 1863, the use of heavy turret lathes in the machine shop can hardly yet be said to be common, and did not begin to be anything like well established before 1890.

First of all, machine-shop managers, even in America, are extremely conservative and slow to adopt new methods which involve radical departures from old and well-tried means and methods. In the next place, the use of turret machines with fixed cutting edges

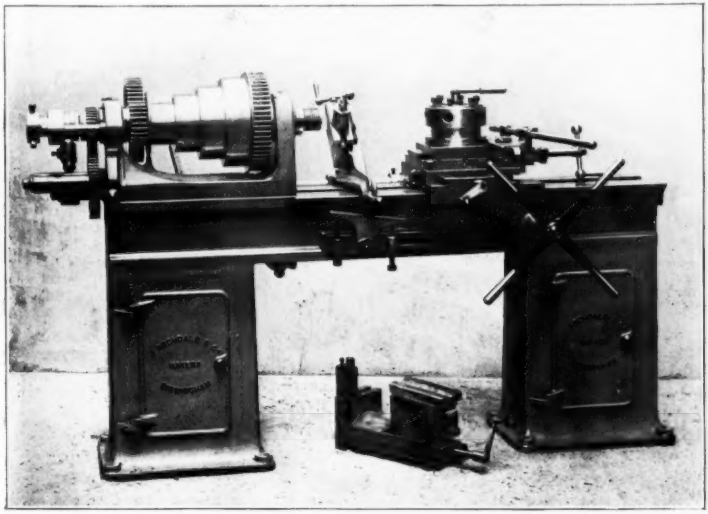


13-INCH FORMING MONITOR LATHE.
Has friction back gears and auto-chuck. Made by Windsor Machine Co.

seemed to demand a great number of repetitions to render this procedure profitable, and while it sometimes occurred in machine shops as managed up to, say, 1885, that numbers of duplications within turret-machine sizes were required, the cost of installing new and high-priced tools, and equipping those costly creations with the necessary expensive outfit of special tools to make them available for producing the duplicate parts required, made managers hesitate to make the formidable venture.

Again, all of the tools which make the best American shop practice what it is to-day depend on the presence of the thoroughly-skilled tool-maker in what may be termed commercial quantities. No manager is willing to install any system which depends on skill and ability beyond his own attainments, especially if the class of talent which must be employed is in limited supply. In this case, even if the manager is sufficiently venturesome to wish to drop his old routine in favor of an innovation, the mere fact that the working of the new method depends on one man, whom it is not easy to replace in case of accident or disaffection, is quite enough to forbid the change. No manager would willingly undertake a new scheme without a visible supply of

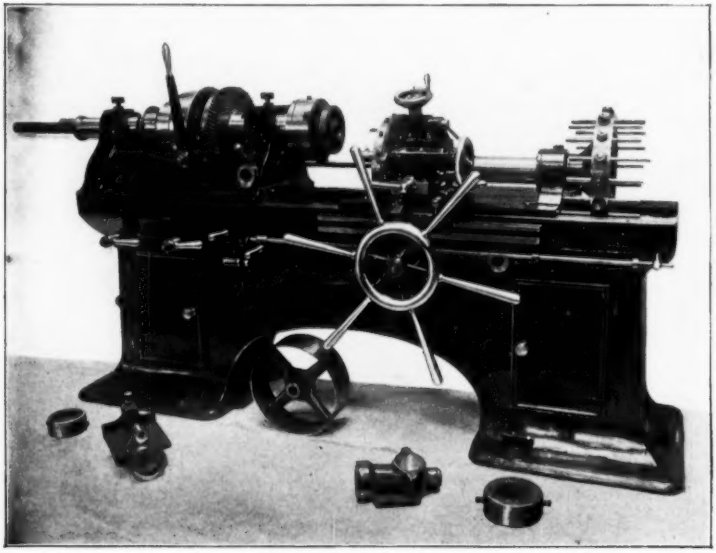
the needful elements to carry it to success, and but very few successful managers are personally compounded of skilled workman and inventive talent in that degree which is essential to the creation of a first-class tool-maker. Within a very few years the "tool room," or special tool-making department, fully supplied with fine tools and containing really capable tool-makers, was a very rare feature even in the best American machine shops. Even now, though every shop of any pretensions to good management has a tool room, it is very often a mere exchange for issuing to the workmen small tools made elsewhere and taking them back again when the hands are through with them. Very often a tool-room is seen containing fine tools which are not in real use, because tool-makers capable of making them economical and valuable factors in the shop-production are not supplied. There is no more melancholy spectacle than a well-equipped tool room which is of no actual benefit to the concern owning it, and no more pitiful object than the manager who forgets the supremacy which must ever belong to the man of high executive ability, and secretly fears to employ really good tool-makers because he well knows that their special qualifications are beyond his own technical limitations.



BRASS-FINISHER'S CAPSTAN LATHE.

The turret carries six tools, and has longitudinal movement by lever or screw and traverse movement for facing, etc. Also swivels for boring or turning taper. James Archdale & Co.

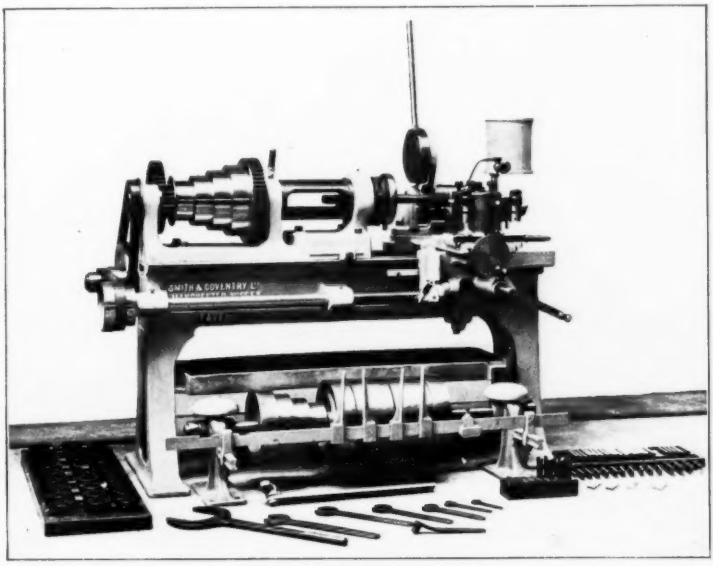
Semi-automatic machine tools, to within the last decade, demanded a well-equipped tool room, and an adequate force of good tool-makers for successful performance. This involved a large new departmental expense, not likely to be recouped by the employment of a few turret machines on a limited range of work. Now, the case is quite different. Competent tool-makers are present in almost every respectable shop, tools of precision are seen everywhere, the milling machine and the grinding machine are in common use, and, more than all else, two or three resolute and courageous inventors have applied themselves boldly and pertinaciously to adapting the turret to general machine-shop use, with such success that, in some instances, one single piece can be finished more quickly with the fixed cutters than by using the engine lathe. This means that a number of tools can be fixed in their



A GERMAN REPETITION LATHE.
Made by the Leipziger Werkzeug-Maschinen-Fabrik (the Pittler Co.).

proper positions, requiring a considerable expenditure of time on the part of the machine tender, and yet the actual finishing of the piece can be accomplished so much more quickly with the fixed cutters than by the repeated cuts and measurements needful with the engine lathe, that the total time consumed in producing the piece on the semi-auto-

matic tool, tool-setting included, is less than that of a good turner, using a good engine lathe. It means also that great inventive skill, and that of the highest order, has been applied to the turret machines as originally produced, so that the skilled tool-maker's intervention is far less employed than anyone, however familiar with the use of the

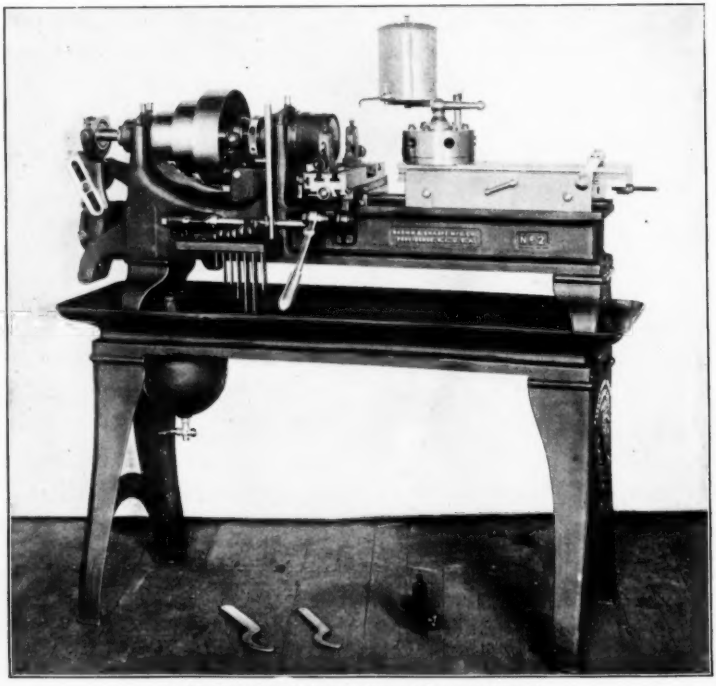


OPEN HOLLOW-SPINDLE STUD LATHE.
For making studs, screws, etc. from the bar. Smith & Coventry.

turret, would have deemed possible ten years ago. It is a case once more of high intelligence embodied in the machine in the form of superior tool-holding appliances, which permits the cutting tools themselves to be of the simplest possible description, and enables these simple tools to be accurately set and securely fixed in position, with the least possible expenditure of time and intelligence.

The first turret machines, like all engine lathes except those of the highest class worked under conditions of the most exceptional character, were incapable of producing screws having threads of standard form and accurate pitch. The early English tool-makers took great pride in their screws, which were, however, extremely imperfect. Even to-day good engine lathes with new lead screws cut very imperfectly-pitched screws, and where the lead screws are worn

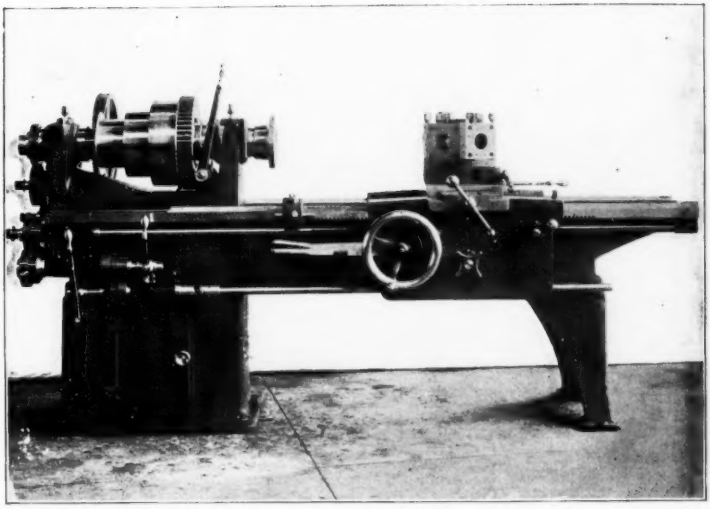
by use, they cut screws so far out of pitch as to lead to serious trouble in machine construction; hence the myriad contrivances in the way of nut fastenings to keep screws from working loose, an occurrence so common that it has passed into common speech, "a screw loose somewhere," meaning that, while all expected care has been used, failure



SCREW MACHINE WITH AUTOMATIC WIRE FEED.

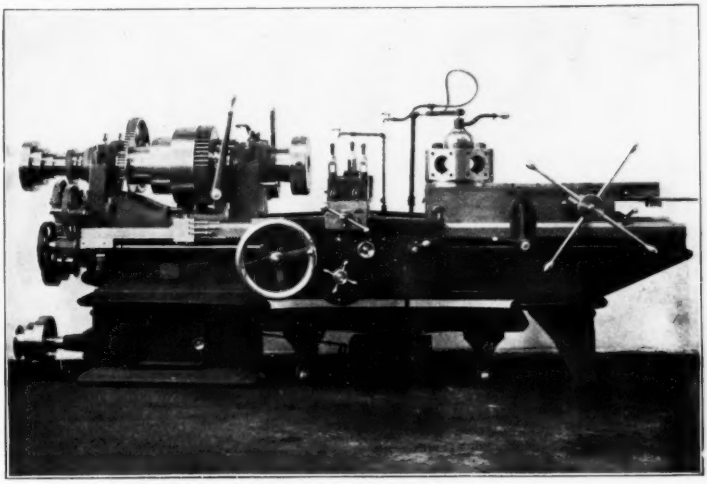
For turning, facing, boring, screwing, tapping, or finishing small parts of machines or tools from bar stock or forgings or castings. Diameter of hole through largest feeding finger, ¾ in.; turns any length to 4 in. Brown & Sharpe Mfg. Co.

results instead of success. This paper affords no space for a treatise on screw cutting, but it is enough to say in few words that a really accurate screw, true to pitch and thread form, is an almost impossible and almost unknown production, while true nuts which would accurately fit a true screw are even more rare. These troubles with screw forms are well known, and the leading mechanics of the world are widely separated as to the pitch for a given diameter and the form of



COMBINATION TURRET MACHINE. SWING 22-IN. DIAMETER AND BED 8½ FT. LONG.

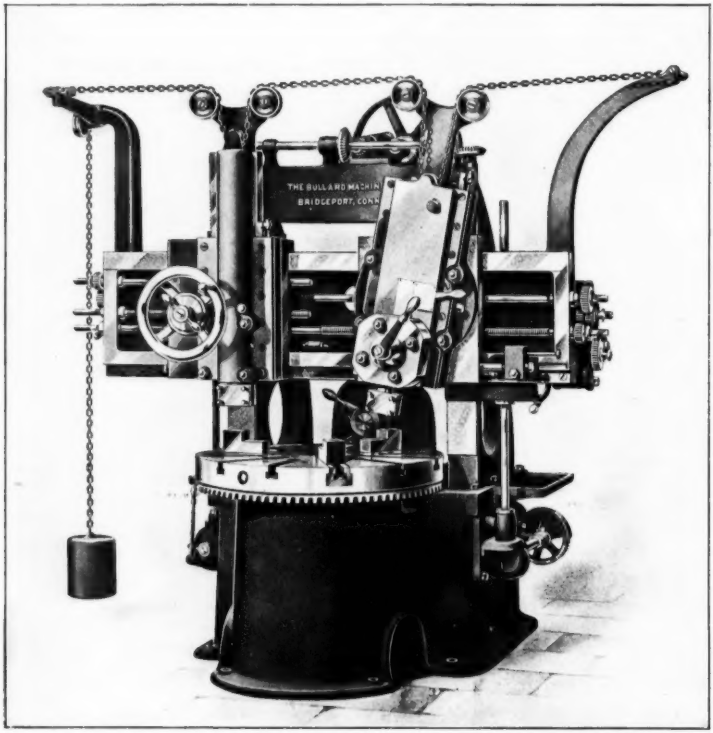
Hexagon turret 12-in. diameter with six 2½-in. holes, permitting a bar to pass entirely through the head. Bullard Machine Tool Co.



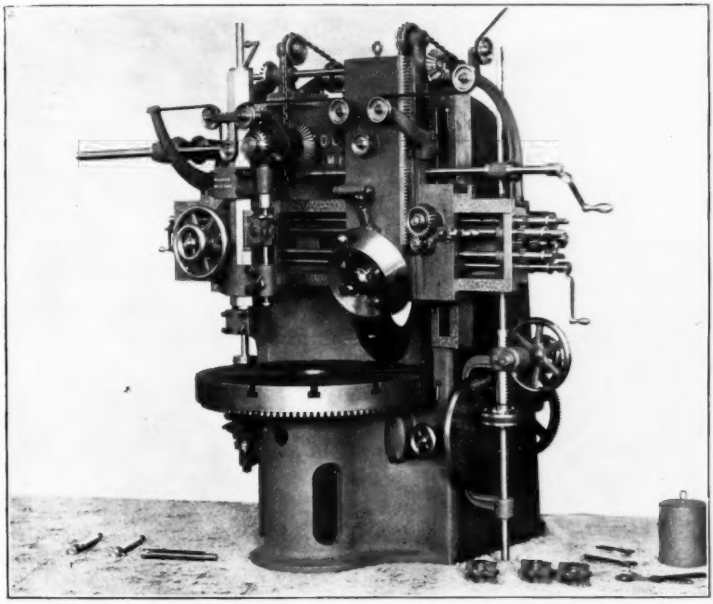
TURRET MACHINE WITH SWING 26 IN. OVER THE WAYS AND BED 10 FT. LONG.

The spindle has a hole 3⅜-in. diameter, and the hexagon turret has six 3½-in. holes. The cross slide carries three tool posts. Turret unlocks and revolves automatically at any point between 8 and 22 inches. Bullard Machine Tool Co.

thread most suitable to use. The standard English thread, adopted first by Clement and made standard by Whitworth, has a round top and bottom with straight sides, and is an excellent form. The American standard thread, fixed by Sellers, has a flat top and bottom, connected by straight sides, and is also an excellent form, the Sellers system being marred, however, in my opinion by far too coarsely-pitched screws below ¾ ins. diameter. Much finer-pitched small screws are still in general use among the New England tool makers, and it would be advantageous to establish a second set of pitches for small screws. In America the worst of all possible screw forms is still used—the 60° angle V-thread, sharp top and bottom, which should be utterly discarded, as it is impossible of accurate production.



BORING AND TURNING MILL WITH ONE TURRET HEAD AND ONE SPECIAL HEAD.
The turret is square and has four 2½-in. holes. Capacity, 42-in. diameter and 30-in. height. Weighs 9,000 lbs. Bullard Machine Tool Co.

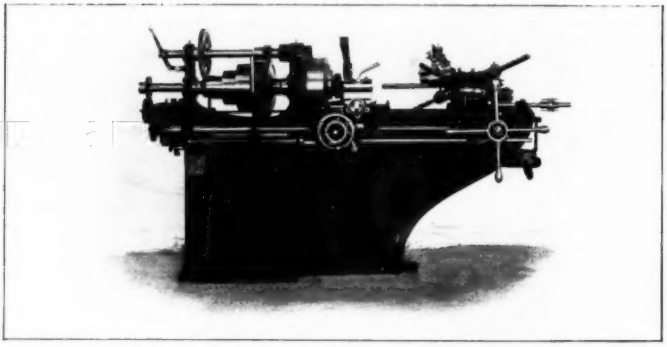


BORING AND TURNING MILL WITH TURRET ADAPTATION.

One head carries a turret and the other a thread-chasing attachment.
Made by the Niles Tool Works.

For all that is here said, the general character of screw threads and screw forms of body and head have been vastly improved by the general use of the turret machine in ordinary screw making, although no good very small screws can be produced on machines of this class. But for all ordinary machine sizes of screws, the flat-turret lathe as designed by, and built under the management of, James Hartness can and does produce screws more nearly approaching accuracy than any lathe in common use.

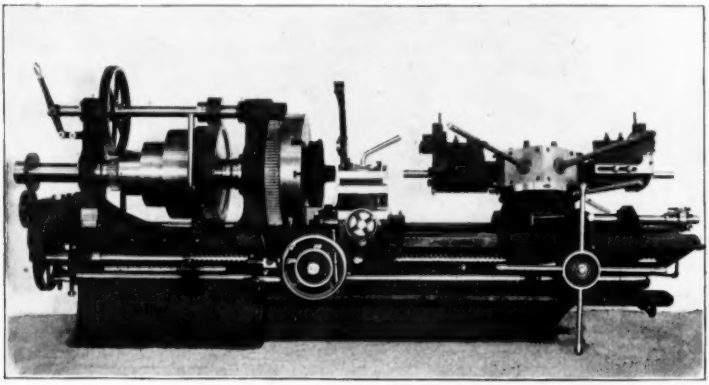
To reach this highly important result, Hartness began at the beginning, with the molecular constitution of his cutting dies, partly soft and partly hard so as not to suffer distortion in tempering, and followed this by a new method of cutting his dies, which renders accuracy possible and makes a close approach to accuracy inevitable. Next he changed the functions of his die threads, making some of them act as cutters while others act as guides, all in simple and certain ways, evincing the very highest powers of reasoning from



A SMALL SIZE OF THE GISHOLT TURRET LATHE.

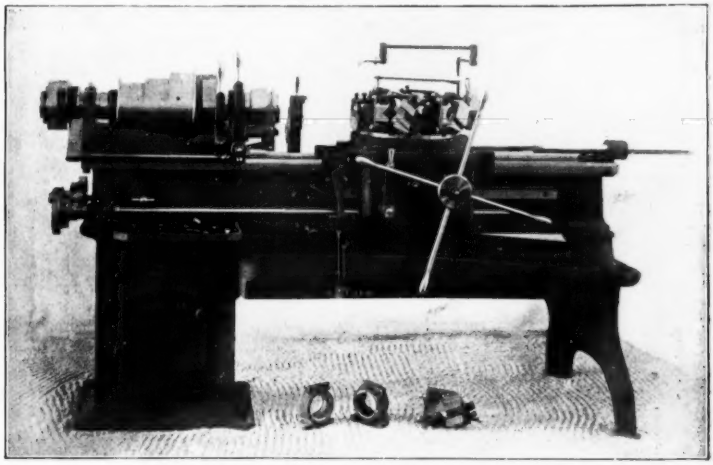
cause to effect and of combining methods and means, with the magnificent industrial result of producing more generally-accurate screws in machine-shop sizes than ever before made, at a cost far below that of the most indifferently-cut screws made on an engine lathe, or on bolt-cutters of common description.

Like the legendary pilgrim of Kooru, who spent three thousand years in selecting and fashioning his immortal staff, Mr. Hartness has confined his attention to the production of a single tool, his flat-turret lathe, in one size only. The Hartness flat-turret lathe makes work from the bar up to 2-ins. diameter x 24-ins. length, and swings 16 ins. over the sheers and 14 ins. over the apron, for chucked



THE GISHOLT TURRET LATHE IN ITS LARGEST SIZE.
The turret is shown fitted with tools for special work of the character shown on pages 386 and 387.

work. None of the highly interesting mechanical features of the lathe are here illustrated, preference being given to illustration of pieces produced by this tool, with the time of production given in each case, as being better calculated to direct the attention of shop managers to the labor-savings which can be made by the use of tools of this character. The work produced is as nearly accurate as that of good engine lathes, and the time consumed is but a fraction, and in most cases a small fraction, of that required by the lathe. The screw threads produced are far superior to any ordinary machine-shop work, and accurate screw cutting is of the highest importance both in the cost of



THE HARTNESS FLAT-TURRET LATHE.

The turret is a flat, circular plate, mounted on a carriage containing the controlling mechanism. The form and connections are designed to secure great rigidity and accuracy. Cuts 2-in. diameter up to 24-in. length. Made by Jones & Lamson.

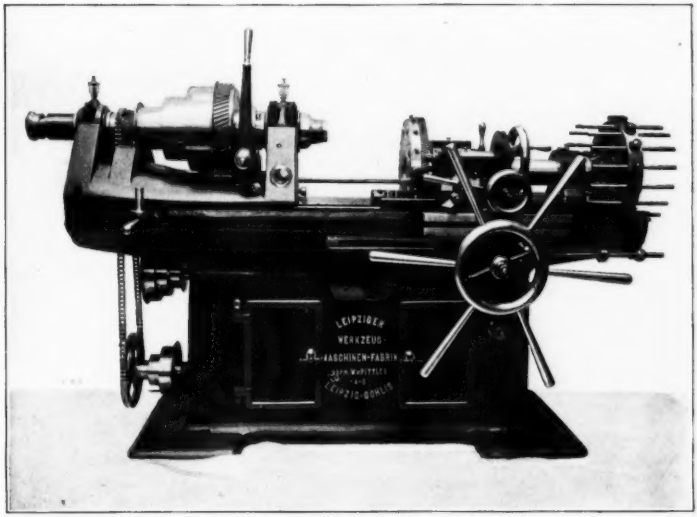
machine production, and in the value and efficiency of the machine produced. While the flat-turret lathe can produce a great variety of chucked work very cheaply and accurately, it is chiefly intended for making work from the bar, to be finished inside of 2 ins. diameter x 24 ins. long. At first sight these seem to be small dimensions, and to afford but a narrow field for invention and for industrial application. In point of fact, however, these sizes include by far the larger part of all engine-lathe work done in all shops, and, in addition, the length may be very considerably extended to meet special cases.

As to the field for invention afforded in the effort to produce a

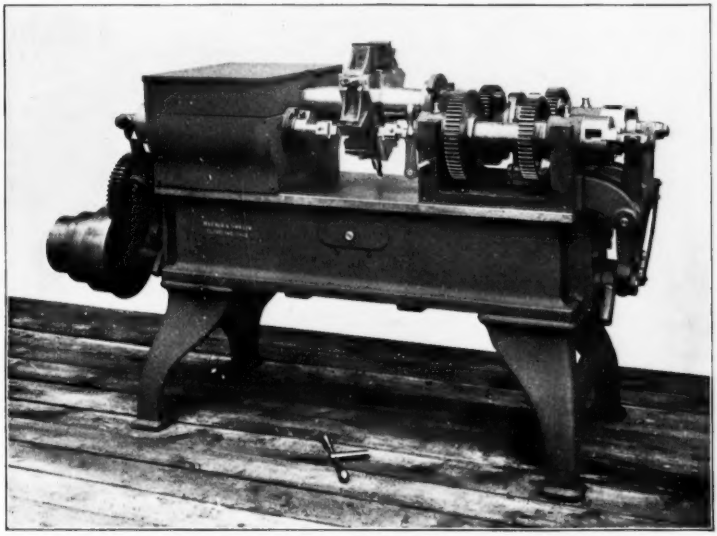
BORING AND TURNING MILL WITH SWIVEL TURRET HEAD.

Capacity, 30-in. diameter. Made by Bullard Machine Tool Co.

perfect tool of the flat-turret-lathe class, it is boundless. Successive efforts have been required in the bar-feeding means and in the chuck which grips the bar in the spindle, although the end seems now to be reached in a chuck which holds a bar of round, square, or hexagonal section with absolute certainty and rigidity, of any size from 2 ins. to ⅜ in. The screw-threading die is a marvel of simplicity and ingenuity, and the thread-cutting dies are perfectly interchangeable, and are readily sharpened, and this whole threading die, which is made almost entirely on the flat-turret lathe, and, I believe, wholly without hand fitting, is a really wonderful testimonial to the powers of the machine. In the flat-turret lathe the turret has been given a wholly new form, the turret base rising only a very little distance above the saddle gibbed to the sheers, which supports it so that the work passes over the turret base, and the tools do not overhang. The turret-turning action is so arranged that the turret stops only at the places required, instead of making idle stops; each tool travels the length of its own



THE PITTLER REPETITION LATHE.

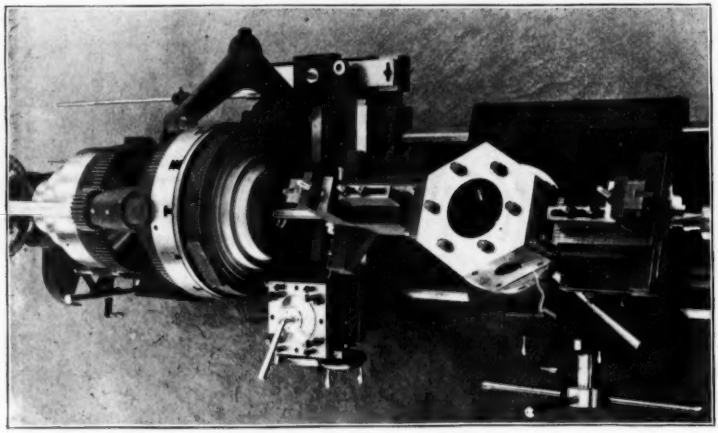


AUTOMATIC BORING AND TAPPING MACHINE FOR IRON OR BRASS WORK.

For boring, facing, chamfering, and tapping the pipe ends of valves, cocks, union nuts, etc. While one rough casting is being bored and faced the preceding one is being tapped, and the finished valve preceding that is being removed. Warner & Swasey.

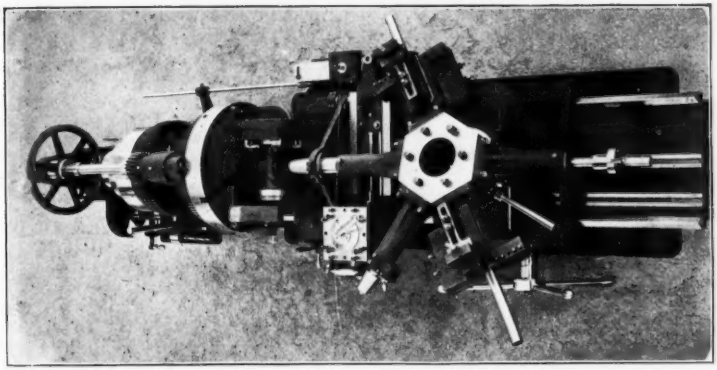
cut only, and the work is held firmly up to the tools; each turning tool and back rest is readily adjusted to any size; each position of the turret has an independent feed stop, and the turning tools are of the simplest form possible. Many of these highly-important features are impossible with the ordinary form of turret, and the flat turret makes new functions of the revolving tool-carrier practicable.

Thus we finally have a form of Maudslay's slide rest, equipped with Stone's highly-advantageous turret so as to carry a number of cutting tools, and through the Hartness devices and inventions we have both the tools and the work far better supported than is possible with any other form of metal-working tool in use, and these vast ad-

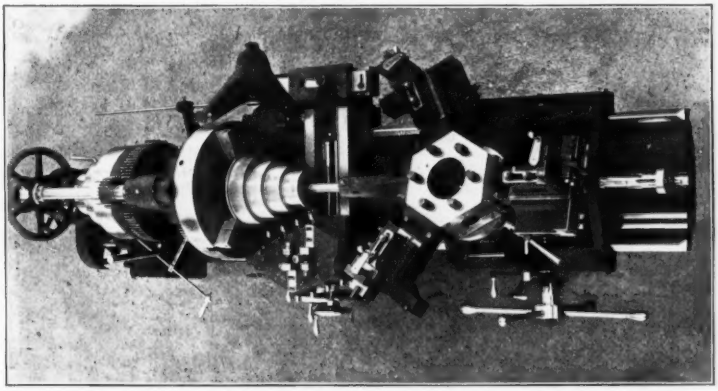


THE GISHOLT TURRET LATHE AT WORK.
Equipped with tools for finishing cylinder heads (second operation). Columna Locomotiv Fabrik, Columna, Russia.

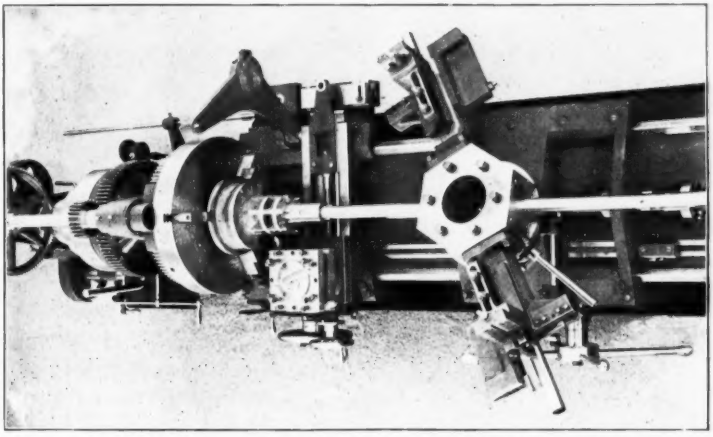
vantages, combined with the Hartness threading die, greatly superior to anything previously used, enable studs, shouldered bolts, handles, hollow pieces and long screws to be produced at a labor-hour cost which, even as late as 1890, would have been pronounced impossible by the most advanced constructor of machine tools. Indeed, it is even now almost impossible to believe that the pieces shown in the dimension drawings, p. 384-385, could have been produced in the times noted with each, and the machine-shop manager having only engine lathes for producing work of the class shown cannot study these simple drawings too carefully, as they will clearly show him that he is paying from four to ten times as much for labor on such work as he need pay.



Tools set for finishing valves in the Maschinen Fabrik Augsburg, Augsburg, Germany.

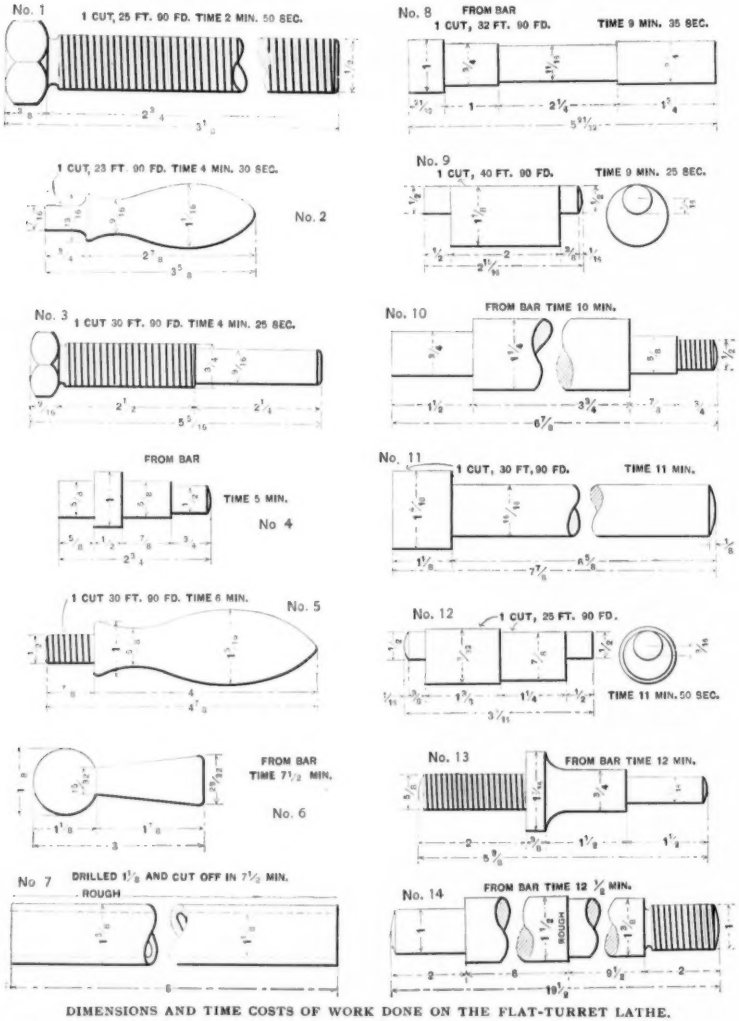


Arranged for turning cone pulleys in the shops of Ludwig Loewe & Co., Berlin, Germany.



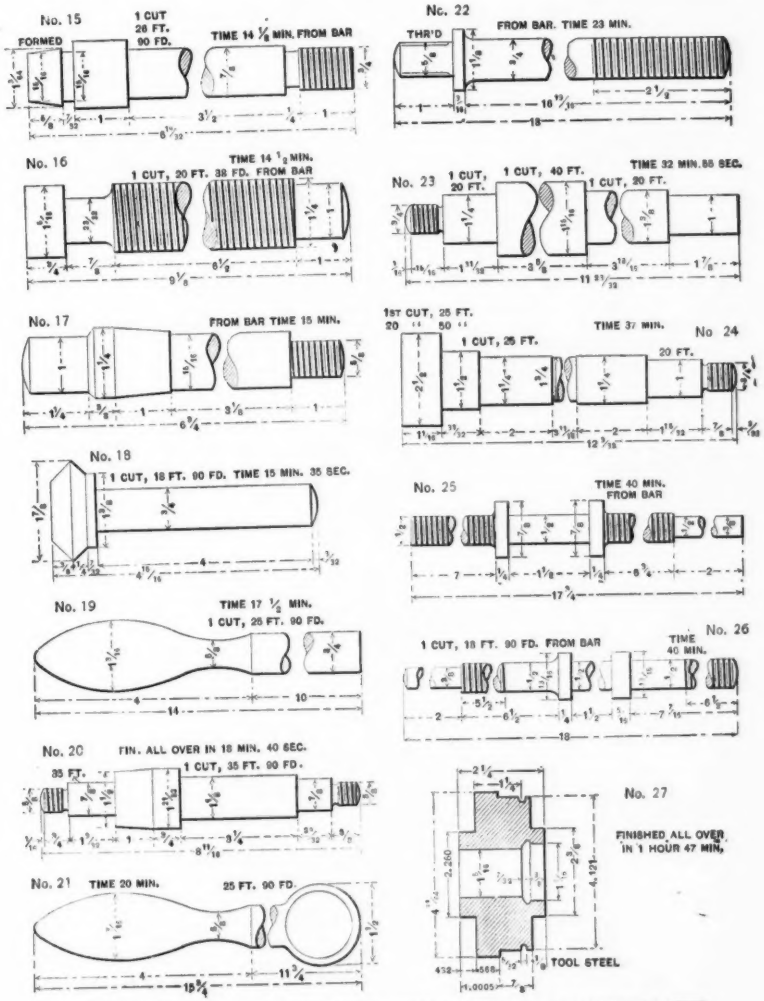
Equipped for finishing commutator shells in the works of Postel Vinay, Paris, France

TOP VIEWS OF THE GISHOLT LATHE, FITTED FOR SPECIAL WORK.


No. 1
1 CUT, 25 FT. 90 FD. TIME 2 MIN. 50 SEC.
No. 2
1 CUT, 23 FT. 90 FD. TIME 4 MIN. 30 SEC.
No. 3
1 CUT 30 FT. 90 FD. TIME 4 MIN. 25 SEC.
No. 4
FROM BAR
TIME 5 MIN.
No. 5
1 CUT 30 FT. 90 FD. TIME 6 MIN.
No. 6
FROM BAR
TIME 7½ MIN.
No. 7
DRILLED 1⅜ AND CUT OFF IN 7½ MIN.
ROUGH
No. 8
FROM BAR
1 CUT, 32 FT. 90 FD.
TIME 9 MIN. 35 SEC.
No. 9
1 CUT, 40 FT. 90 FD.
TIME 9 MIN. 25 SEC.
No. 10
FROM BAR TIME 10 MIN.
No. 11
1 CUT, 30 FT, 90 FD.
TIME 11 MIN.
No. 12
1 CUT, 25 FT. 90 FD.
TIME 11 MIN. 50 SEC.
No. 13
FROM BAR TIME 12 MIN.
No. 14
FROM BAR TIME 12 ⅛ MIN.
ROUGH

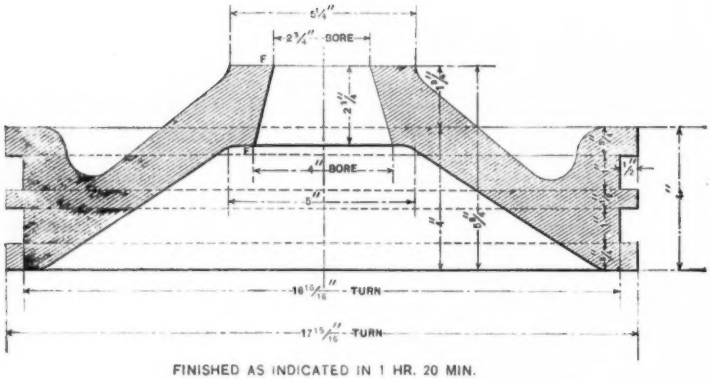
DIMENSIONS AND TIME COSTS OF WORK DONE ON THE FLAT-TURRET LATHE.

Take figure No. 1, for example—a plain, square-head, ½-in. screw, necked under the head, 3⅛ ins. over all. This screw was finished from a square bar in 2 min. 50 sec. No. 7, 1⅝-ins. outside diameter by 6 ins. long, has a hole 1⅛-in. diameter through it, and is bored and

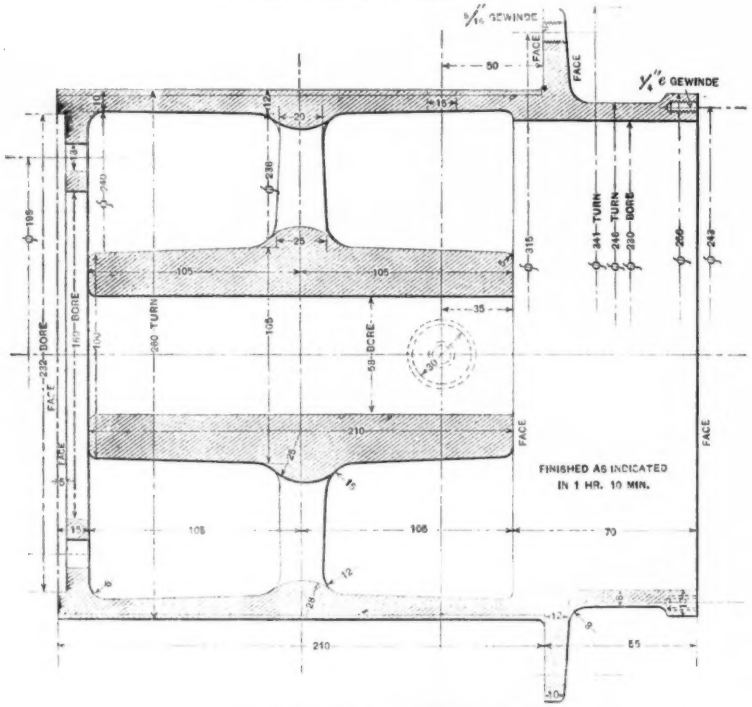


ADDITIONAL EXAMPLES OF AUTOMATIC PRODUCTION BY THE HARTNESS LATHE.

cut off in 7½ min. Nos. 25 and 26 are very elaborate, 17¾ and 18 ins. long respectively, shouldered and threaded, with reduced sizes between collars, and are by no means easy pieces for a good turner to produce, yet the lathe works them out from the bar in 40 min. each.

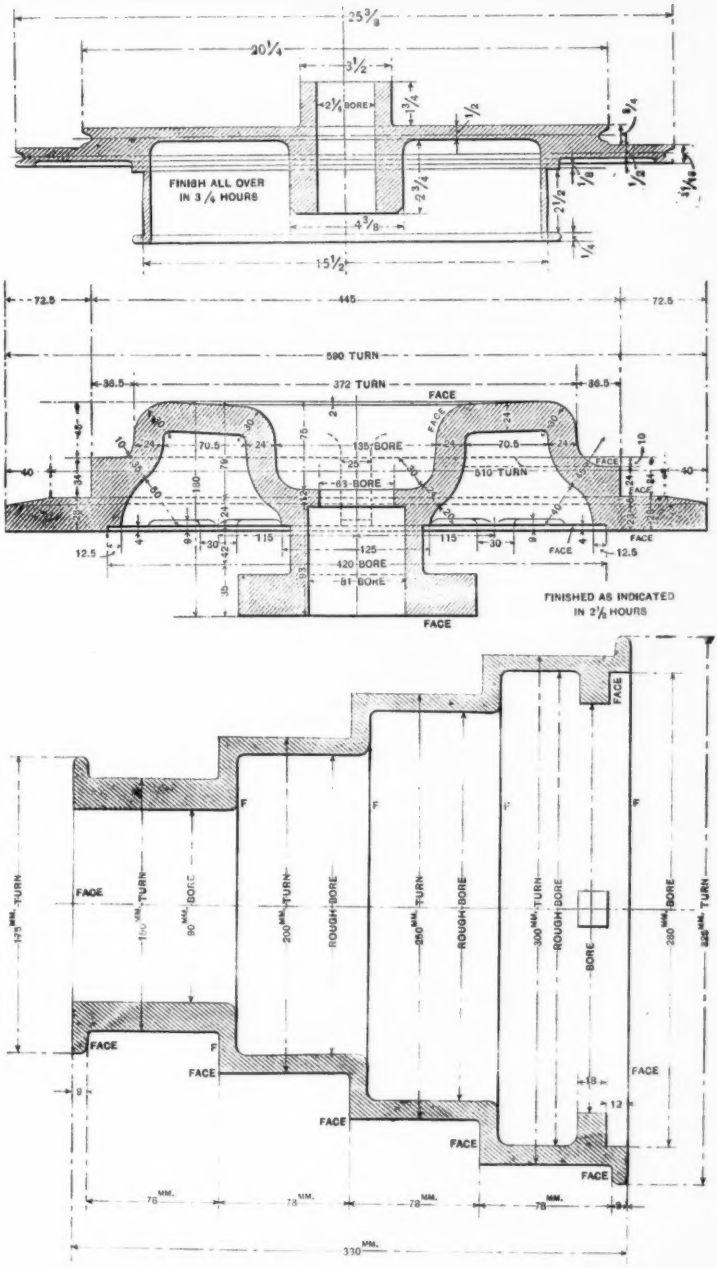


FINISHED AS INDICATED IN 1 HR. 20 MIN.



EXAMPLES OF THE WORK OF THE GISHOLT LATHE.

The figures above and on page 387 show the dimensions of large repetitive work—a piston special forms of pulleys and sheaves, cone pulleys, etc.—as finished on the Gisholt lathe, with the actual time required to finish each piece.



TIME - 2 HRS. 45 MIN.
FINISHED AS INDICATED

The next important step in the development of cheap repetitive machine-part manufacturing was the adaptation of the turret-machine to do for separate cast-iron or cast-brass pieces what the Hartness flat-turret lathe does for parts produced from the forged bar, enabling all pieces of this class, within certain size-limits, to be finished far more rapidly than can be done on the best engine lathe, and also insuring accurate duplications. The Gisholt lathe is the pioneer example of this class, having large speed variations and great stability, with special appliances of a highly ingenious character devised specially to adapt it to the finishing of cone pullies, gear blanks, and other similar parts of machines. Although the Gisholt is not a "single production" machine shop, it is still so closely confined to one type as to fall easily into the class of highly specialized manufacturing. General views of the latter are given, with many scale drawings of work executed (p. 386-387), each marked with the hour-cost of finishing, the time expenditure being low in all examples, and in many cases surprisingly small. Where there are as many as five pieces to be duplicated a marked saving in time cost of production can be thus effected, and the examples given are highly instructive. Many other inventors and makers, American, English, and Continental were early in the field of turret-adaptation, with devices some of which are shown in the accompanying illustrations and many of which are marked by ingenuity and originality. Applications of the turret to boring mills and vertical drilling machines, in large and small sizes, extend to these tools the accurate repetition and rapidity of production which are the characteristic benefits derivable from the turret.

The turret has also been applied to metal-working tools, in which, instead of carrying separate tools successively to the work, the work itself is carried by the turret and thus successively presented to different cutting tools occupying fixed positions. This use of the turret has been confined principally to the finishing of valve bodies.

Thus through successive efforts of many skillful men, and a vast expenditure of thought and study and nearly a hundred years of time, the workman guiding a single cutting tool in the weak and uncertain grasp of his unaided hands, has been transformed into the workman controlling many cutting tools, all firmly held by the machine itself, and brought to bear upon the work in proper sequence, with the result of reducing the time-cost of the work-production vastly below the best that the most skillful hand-worker could do, while at the same time making far more accurate repetition work than is possible under any manipulation of hand-guided cutting tools.

ELECTROLYTIC PROCESSES IN INDUSTRIAL OPERATIONS.

By Dr. W. Borchers.

NO careful manager of a household, manufactory, or any business enterprise depending upon the consumption, exchange, or production of commodities will neglect to ascertain the best source of supplies. He will not only take care to purchase material at the proper time, but will also seize a favourable opportunity to acquire the apparently valuable commodity in more than sufficient quantity, provided he has the means and knowledge requisite to keep the surplus until the appropriate moment with its valuable properties unimpaired. This point of view is so natural that, wherever the conditions are approximately well regulated, it may be assumed as self-evident. And yet the greater the scope of our observation, the greater the enterprise whose economic management we are scrutinising, the more these self-evident principles of economy appear, or rather have appeared, to be put into the background. A contemplation of the prevailing method and means of utilising the so-called forces of nature—or, let us rather say, the available natural sources of energy—will show this most conspicuously.

The entire quantity of natural energy which we possess in the present condition of the earth's crust has its origin, as is well known, in the radiating energy of the sun. From the existing stores of heat in the interior of our globe we derive advantage at but a very limited number of places. Everything else which puts and keeps in motion the action of machinery, mechanisms, and living organisms is derived directly or indirectly from the sun. We distinguish:

1. Radiating energy, visible light and invisible rays ascertainable by their chemical or electric effects.
2. Heat.
3. Mechanical energy.
4. Electrical energy.
5. Chemical energy.

These various forms of energy may be converted more or less easily one into the other.

With exception of some forms of mechanical energy it is principally chemical energy only which can be stored in transportable form;

this is true of heat and electrical energy to so small an extent that they need not be here considered. The most fugitive of all forms is radiating energy. Let us note what becomes of this energy upon striking our globe. One part of it is at once converted into heat, in which form it penetrates to a moderate depth into the earth, doing work which is partly mechanical, partly chemical. The mechanical work consists chiefly of the evaporating and lifting of water. If we assume a mean rainfall of one metre and the height of the clouds at 3,000 metres, the work done by the sun equals 661,560,000,000 h. p. per second. Only a vanishingly small part of this labour can be utilised by us, but today the attempt is made to seize it wherever it can possibly be caught.

Not less noticeable a part of the sun's energy is directly or indirectly converted into chemical energy. Through the reaction taking place in the bodies of plants, and simply expressed by the formula $6CO_2+5H_2O=C_6H_{10}O_5+6O_2$, we obtain wood and other plant fibres, starches, and similar substances with considerable stores of energy suitable for creating heat in and outside of our bodies.

It has been proved that about one kilogram of wood can be made to grow annually on one square metre of suitable soil. From one square kilometre of wood or farm land we accordingly obtain 1,000 tons of vegetable matter with a thermal value of 4,000 calories per kilogram. This is equivalent to a continuously-working power station of about 700 h. p. Assuming but a very small proportion of the entire terrestrial surface of 136,038,872 sq. km. to be capable of supporting vegetation, we would in this case also reach an imposing figure. For many thousands of years this vegetable growth, with its incident mouldering and decaying processes, has been in operation as a sunlight accumulator, gathering into the earth's crust stores of energy in the form of peat, lignite, coal, etc.

Up to the present time we have consumed principally the last named stores, and that in no economical manner, using the most of the best, because considerations of transportation required the greatest possible storage of energy per weight unit. The turf and coal beds of lower calorific value have hardly been noticed, and large industrial centres have been developed only upon the richer coal basins. No reproach is hereby intended against the old working methods of industry nor against our old and accustomed manner of life, even though, here and there, the waste was greater than necessary; because, as I have previously stated, in order to make a favourable bargain-purchase, there must first exist the possibility of preserving the purchased supplies in such manner that they always represent at least

the expended cost. Such a possibility, however, was out of the question until within the last few decades, only the most favourable opportunities offered us by nature to draw upon cheap and available powers having been utilised, and these mainly water powers. A point here or there, situated near the great thoroughfares of commerce, has already admitted of a better exploitation of a water power, but on the whole, notwithstanding the best intentions and an active spirit of enterprise, there has been a lack of effective work.

The evanescent mechanical energy of flowing water is irrevocably lost with every quantity of water which flows past unused. The same is true for various peat and lignite beds lying near the surface and exposed to the air. Their heat-producing qualities are so low that it is impracticable to transport them, and they certainly gain nothing through the influences of the atmosphere. Because of their diminishing value, these stores of energy must also be considered as temporary and their application for useful work, from a politico-economical standpoint, should be estimated accordingly.

At the present time, however, we have the means to bring into collected and portable form these benefits constantly coming to us from the sun, even though they can be seized only at the moment when, and the place where, they reach us. At the moment when Werner von Siemens created electro-technology by the invention of a practical dynamo-electric generator he also created the field for the development of the electro-chemical industry. On a moderate scale, this field had long been prepared by the labours of Davy, Faraday, Bunsen, Deville and others.

The true function of the electro-chemical industry is to give a concentrated and highly potential form to the fleeting processes of the forces of nature. The most desirable achievement of electro-technology is to bring the great water powers to existing industrial centres, but in this matter we cannot exceed certain rather narrowly-set limitations, and at best we are always dependent upon the copper leading-string which carries the impulse from the sources of energy. The necessary freedom of action desired for so many cases is here found lacking. No such limitation attaches to the production of the electro-chemical technology. Let us therefore inquire into the present achievements of this branch of industry, which have been accomplished in the short period of a development of about thirty years, and into its future possibilities.

At the beginning of the present year I collected extensive data for a report to the German Electro-Chemical Society, and I have collected

the results in the following tables. Table 1 enumerates the more important metals and chemical products, obtained either wholly or partly by electrical means, with a statement of the amount actually produced or producible in the near future.

The figures in the table give the minimum, not the maximum, quantities. Producers from whom insufficient information, or none, was obtainable have remained unnoticed.

TABLE I.

	Weight, Tons.	Price per Ton, Marks.	Total Value, Marks.
Aluminum	12,930	2,100	27,153,000
Gold	kg. 21,320	2,800	59,696,000
Copper	166,360	1,500	249,540,000
Sodium	260	4,500	1,170,000
Nickel	182.5	2,500	456,250
Phosphorus	?	4,000	
Silver	kg. 1,475,000	81	119,475,000
Zinc	?	560	
Caustic Soda—70 per cent.	82,060	153	12,555,180
Caustic Potash—80 per cent.	17,280	370	6,393,600
Chloride of Lime—38-40 per cent.	225,000	100	22,500,000
Chlorate of Potash	11,350	655	7,434,250
White Lead	2,500	450	1,125,000
Calcium Carbide	256,244	300	76,873,200
Carborundum	1,585	1,000	1,585,000

NOTE.—In this table the metric ton of 2,203 lbs. is used. The mark may be taken as 1s. or 25c.

Before analysing the figures in this table at greater length the various processes by which these products are obtained will be briefly described. Of the metals of the alkalies, sodium alone need be considered. In all known manufactories it is produced by the Davy (1808) process of electrolysis of caustic soda. The first serviceable apparatus for this process was constructed by H. Y. Castner, and consists of an iron plunger introduced through a tubular support at the bottom of an iron crucible. This plunger is placed vertically in the axis of the crucible and serves as the negative pole (cathode). An iron body fastened to the lid of the crucible surrounds the piston and acts as the positive pole (anode). In the lid, and above the cathode, hangs a receptacle which collects the melted metallic sodium coming to the surface from the cathode during electrolysis, and out of it the metal is ladled. The heating of the apparatus is so contrived that the melted charge poured into the crucible solidifies in the lower portion and remains solid during the electrolysis, thus effecting insulation and sealing the joint; while the sodium and hydrogen are isolated at the

cathode, oxygen is collected at the anode. To separate the latter as much as possible from the sodium, a cylinder of wire gauze is hung between the electrodes.

Other very suitable devices have more recently been constructed by Rathenau, Suter, and the Aluminum Industry Stock Company on the one hand, and by Becker on the other. The former recommend the use of cathodes with round or conical heads dipping but slightly into the electrolytes. From time to time the metal is ladled from the cathodes and separated from the accompanying impurities.

Becker's apparatus is a modification of Castner's, and enables the principal parts to be more easily maintained at the required temperature while at the same time it is sought to make the collection and removal of the metal easier.

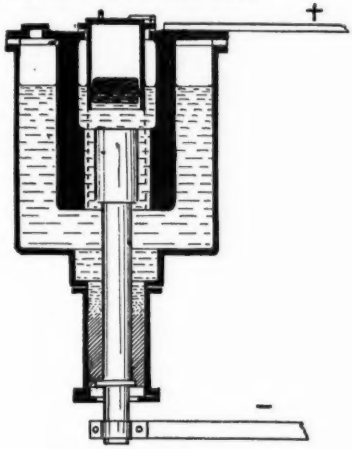


FIG. 1. CASTNER'S SODIUM APPARATUS.

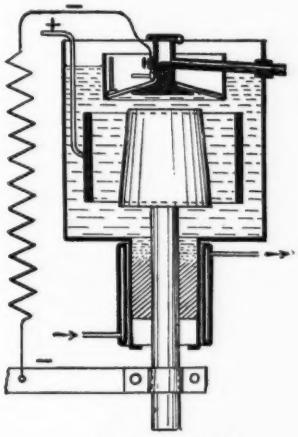


FIG. 2. BECKER'S SODIUM APPARATUS.

Though no figures showing the extent of the production of magnesium were procurable, we must not omit to mention it. It is one of the metals that has been obtained from melted salts by electrolysis in scientific laboratories as well as in commercial practice. The present process of obtaining it is founded upon the investigations of Bunsen, who in 1852 obtained magnesium from melted magnesium chloride by electrolysis, and upon those of Matthiessen, who a few years later proposed, as a source of magnesium, carnallit (magnesium sodium chloride) from which the moisture is more readily removed than from pure magnesium chloride. The apparatus used is an iron crucible

serving at the same time as a negative pole during the electrolysis; a carbon rod, hung in the crucible, forms the anode. The magnesium is deposited in the form of balls on the walls of the crucible, and the chlorine is carried off from the vicinity of the carbon rod through porcelain tubes.

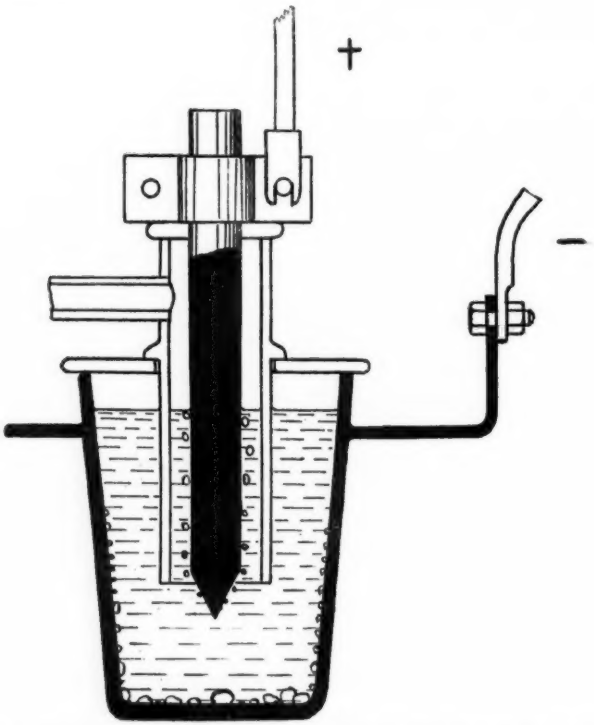


FIG. 3. CRUCIBLE FOR ELECTROLYTICALLY EXTRACTING METALLIC MAGNESIUM.

The preliminary conditions for the manufacture of aluminum were also given in the works of Bunsen and St. Claire-Deville in the year 1854. These two scientists had already proved that aluminum could be separated from its fused compounds by electrolysis. Deville had already made experiments to replace the aluminum removed from the fused mass by adding its oxide, thus making the process a continuous one. But as the cost of electricity for the purpose of heating the charge was prohibitive at that time, crucibles heated by firing from

the outside had to be used. No material for a crucible could be found which, when filled with melted chlorides and fluorides and heated from without, could withstand the influence of the charge, and would not fill the metal with impurities. Héroult suggested the idea of doing away with external heating by melting the electrolyte and keeping it in melted condition by the heat electrically generated by the electrolysis current; this made possible the present development of the aluminum industry. According to Héroult's process, cryolite is melted first by the electric-light arc in an iron box lined with carbon, the fusion being continued later by the heat produced by the resistance, the charge between the electrodes itself furnishing the resistance. The crucible lining, particularly the bottom lining, forms one of the electrodes, and one or more bundles of carbon plates the other.

During electrolysis a pre-determined quanaity of aluminum oxide is at short intervals introduced into the charge as compensation for the aluminum removed. The metal collecting at the bottom of the crucible is from time to time drawn off through a tap hole.

Deviating from Héroult's furnace, Borchers, with a view of increasing the purity of the metal obtained, recognised the value of lining the crucible with cryolite. The charge in the crucible and the separated metal come in contact only with a pure aluminum compound.

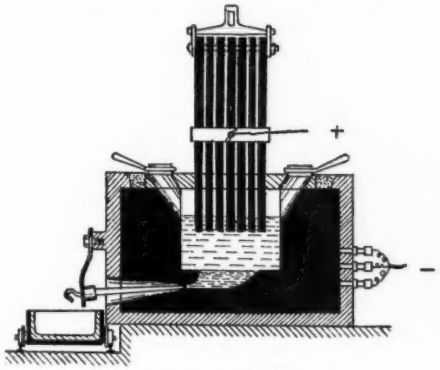


FIG. 4. HEROULT'S ALUMINUM FURNACE.

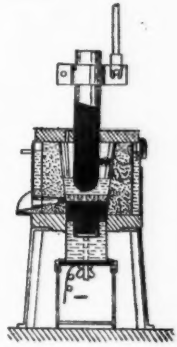


FIG. 5. BORCHER'S ALUMINUM FURNACE.

A metal or carbon pole, introduced through the bottom, serves as the cathode. To preserve the aluminum from taking up impurities by coming in contact with these parts of the apparatus, the poles are sufficiently cooled to prevent any chemical combination occurring there.

Hall's process, which is that of the Pittsburgh Reduction Com-

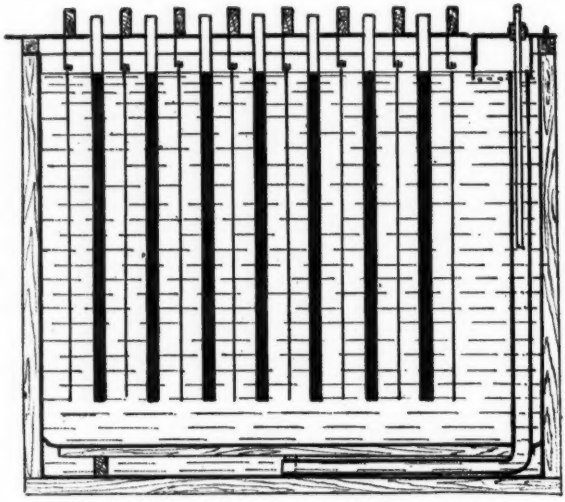


FIG 6. COPPER-REFINING VAT. LONGITUDINAL SECTION.

pany in the United States, also differs from Héroult's by using, as electrolytes and solvent for the aluminum oxide, a mixture of chlorides and fluorides of the metals of the alkalies and alkaline earths.

Copper, nickel, silver, and gold, in so far as electrolysis may be said to be applicable to them, are chiefly obtained in pure form by electrical means from the crude metal produced by the smelter. Gold is also electrolytically deposited from weak solutions obtained by chemical lixiviation processes. In the process for refining the crude metal it is cast into plates, with hook- or eye-formed projections by aid of which the plates are hung upon the electrical conductors. The latter generally rest on insulating wooden frames on the edges of the vats in which the electrolysis is carried on. Aqueous solutions of salts of the respective metals—for instance, sulphate of copper, sulphate of nickel, cyanide of nickel, nitrate of silver, chloride of gold, etc.—are used as electrolytes. The copper, silver and gold solutions are kept highly acid, the nickel solutions as a rule neutral. Plates of the pure metal serve as cathodes and are hung into the bath alternately with the anodes. It is important for the success of the electrolysis that more or less active agitation of the solutions be maintained. This is obtained either by the continual circulation of the solutions through a series of vats, by air-blasts, or by stirring. In the separation of silver

and gold the agitators covering the cathodes are shaped somewhat like clasps, serving the additional purpose of breaking off the silver crystals, which form like needles, and of preventing short circuits.

Zinc, up to the present time, has been obtained only in large laboratories by electrolysing the lixiviates obtained from the roast products of poor ores after careful cleaning; using insoluble anodes of carbon or lead. Tin is principally obtained electrolytically from tin-plate waste. This is pressed into balls and then placed in solutions of caustic soda and sodium stannate in baskets of wire netting which serve as anodes. The iron tank and the suspended iron plates serve as cathodes.

Caustic soda, caustic potash, chlorate of potash, and chlorine are obtained by electrolysis from aqueous alkali-chloride solutions, the chlorine being produced at the anode and the hydrogen, together with the caustic alkali, at the cathode. By suitable constructive appliances or apparatus, and by changing the working conditions, the chlorine and caustic-alkali solution are either carried off separately, converting the former into chloride of lime and the latter into solid caustic soda, or the chlorine and caustic alkali are permitted to influence each other during the electrolysis so that the apparatus produces a solution of chlorate of potash in the place of caustic potash and chlorine. For the first-mentioned process, apparatus is operated by the Aktien Gesellschaft Elektron, Frankfort a. M., by Castner, Kellner, Solvay & Co., Elektrochemische Werke, Bitterfeld, Le Sueur, Hargreaves & Bird, and Richardson & Holland; for the last-named, by Gall & Montlaur, Corbin, Ver. Chem. Fabr. Leopoldshall, Oettel, Hargreaves, and Blumenberg. It would lead us too far to describe all of these in detail. In principle, the various apparatus for obtaining caustic alkali differ

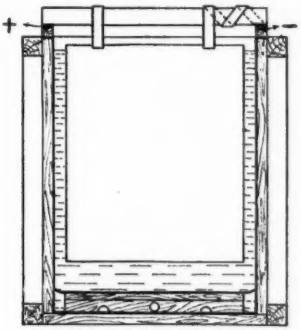


FIG. 7. COPPER-REFINING VAT. VIEW OF CATHODE.

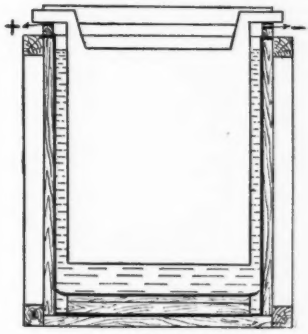


FIG. 8. COPPER-REFINING VAT. VIEW OF ANODE.

among each other in this particular—that the separation of the products is accomplished either by porous diaphragms or by means of quicksilver as a middle electrode.

In the case of a vessel with two communicating partitions, the communication may be cut off by quicksilver; if the one partition then contains salt solution with the anode, and the other water with the cathode, the layer of quicksilver opposite the anode becomes electrically negative and absorbs the alkali metal which it then discharges at its positive electrical side, opposite the cathode, in the other partition, for the formation of caustic potash and hydrogen.

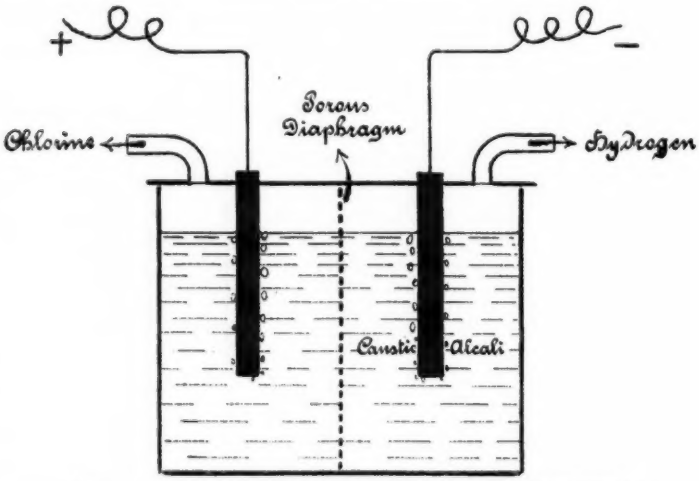


FIG 9 ALKALI AND CHLORINE ELECTROLYSER WITH POROUS DIAPHRAGM.

To obtain chlorate, the diaphragms and other partition walls for the different products of the electrodes are not required, because the chlorine formed at the anode combines with the alkali at the cathode to form an alkali chlorate.

In this case, therefore, the only precautionary measure to be taken is to arrange the cathode and to choose the other working conditions in such a manner that the hydrogen, produced with the caustic alkali at the cathode, can not cause a reduction of the newly-formed chlorate.

White lead is obtained by a process originally mentioned by Luckow, by electrolysing anodes of lead opposite inactive cathodes in a weak solution of chlorate of potash and carbonate of soda. The neg-

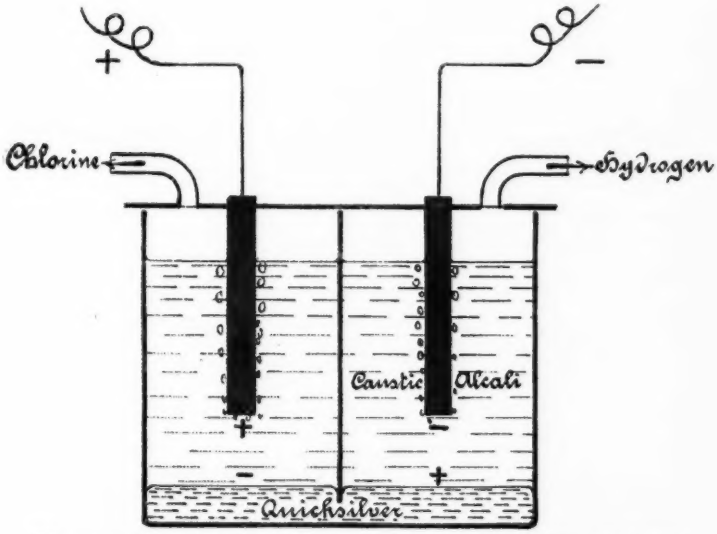


FIG. 10 ALKALI AND CHLORINE ELECTROLYSER WITH QUICKSILVER DIAPHRAGM.

ative constituent of the chlorate of potash promotes the solution of the lead, which is then deposited again through the negative constituents of the sodium carbonate as white lead. In addition to the renovation of the lead anodes, carbonic acid and water must constantly be added.

The methods of producing phosphorus, carborundum, and calcium carbide are purely chemical reduction processes carried on by means of electrically-generated heat. The heating is either brought about by incandescent heating, by placing, in the case of carborundum or calcium carbide, the reduction carbon or special carbon with the desired compound, in the path of a strong current or, in the case of phosphorus, or calcium carbide, by producing one or several electric arcs inside the mass. For this reason, several modifications appear in the various furnaces. The fused product either collects in the furnace, or is tapped off from time to time in

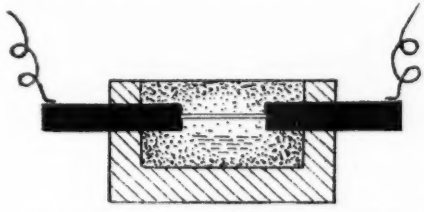


FIG. 11. ELECTRIC FURNACE. INCANDESCENCE HEATING.

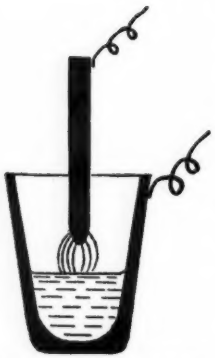


FIG. 12. ELECTRIC FURNACE. DIRECT ARC HEATING.

the manner employed with metallurgical melting furnaces, or is constantly withdrawn by moveable hearths. Other variations are caused by the use of moveable electrodes. For practical purposes the furnace system of Borchers for calcium carbide and carborundum is still further developed, and the furnace system of Siemens for calcium carbide, phosphorus, and many other smelting operations.

That all the products mentioned are merchantable and valuable wares needs no further elaboration on my part. Even those of my readers who are unfamiliar with the metal and chemical trade will find in the above list the names of products the uses of which are well known to them.

Three not unimportant branches of electro-chemical technology—namely, the accumulator industry, the galvano-plastic industry and the well-developed electric-bleaching processes—I must to my regret leave unnoticed, because of the great number of small plants, which cannot be investigated. That the last-mentioned industry, whose development is of but recent origin, is already in extensive operation, appears from the fact that the firm of Siemens & Halske in Berlin and Vienna, and the Elektrische Aktien Gesellschaft (formerly Schuckert & Co.) have installed plants of much more than a thousand h. p. The galvano-technical plants can also be counted by thousands.

The apportionment of the productions just named among the principal countries is shown in Table No. II. The power employed for this production is stated in Table III.

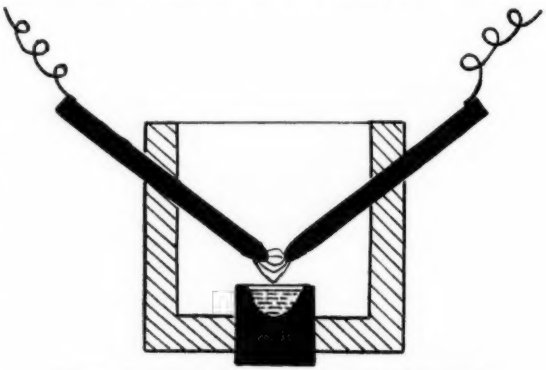


FIG. 13. ELECTRIC FURNACE. INDIRECT ARC HEATING.

TABLE II.

		Aluminum.	Gold.	Copper.	Silver.	Chlorate of Potash.	Caustic Potash, 80 per cent	Caustic Soda, 70 per cent.	Bleaching Powder, 40 per cent.	Calcium Carbide.	Carborundum.	Miscellaneous.
AFRICA.												
Transvaal...	Weight		10,320									
	Value		28,896,000									
AMERICA.												
Canada.....	Weight									1,500		
	Value									450,000		
United States.	Weight,	5,000	7,000	150,000	1,400,000	330		5,120	11,200	60,000	500	Nickel, 182.5
	Value,	10,500,000	19,600,000	225,000,000	113,400,000	216,150		783,680	1,120,000	18,000,000	500,000	456,250
EUROPE.												White Lead.
Belgium	Weight							1,600	3,500			
	Value							244,800	350,000			
Germany.....	Weight		4,000	13,600	75,000	120	17,280	2,600	51,200	12,444	225	2,500
	Value		11,200,000	20,400,000	6,075,000	78,600	6,696,600	397,800	5,120,000	3,733,200	225,000	1,125,000
England.....	Weight,	1,000						11,200	24,500	8,100		Sodium, 260
	Value,	2,100,000						1,713,600	2,450,000	2,430,000		1,170,000
France.....	Weight,	6,120				6,300		45,280	99,030	35,000	800	
	Value,	12,852,000				4,126,500		6,927,840	9,905,000	10,500,000	800,000	
Italy.....	Weight			560						29,450		
	Value			840,000						8,835,000		
Norway	Weight									24,500		
	Value									7,350,000		
Austria.....	Weight			1,000		750		7,200	15,750	21,000		
	Value			1,500,000		491,250		1,101,600	1,575,000	6,300,000		
Russia	Weight			1,200				2,400	5,250	6,000		
	Value			1,800,000				367,200	525,000	1,800,000		
Sweden	Weight					2,000				25,000		
	Value					1,310,000				7,500,000		
Switzerland ..	Weight,	810				1,850		3,300	7,200	28,250		
	Value,	1,701,000				1,211,750		504,900	720,000	8,475,000		
Spain	Weight							3,360	7,350	5,000		
	Value							514,000	735,000	1,500,000		

Weights of gold and silver are given in kilograms; of all the other metals in metric tons of 2,208 lbs. The value of the mark may be taken as equal to 1s. or 25c.

TABLE III.

The Countries Named Below,		Have in Power Plants Already Built or Projects Undertaken,			The Value of the Foregoing Installations Being, in Marks,
		Wa er Power, h. p.	Steam Power, h. p.	Gas Power, h. p.	
AFRICA.	Transvaal.....	.....	454	.....	28,846,000
AMERICA.	Canada.....	1,500	.....	.....	450,000
	United States.....	72,300	11,750	2,500	390,025,760
EUROPE.	Belgium	.....	1,000	.....	594,800
	Germany	13,800	16,173	.....	55,138,200
	England.....	11,500	8,150	20	9,083,600
	France	110,140	1,300	.....	45,111,340
	Italy.	29,485	.....	.....	9,675,000
	Norway	31,500	.....	.....	7,350,000
	Austria.....	29,000	23	.....	10,967,850
	Russia	6,075	1,500	.....	4,492,200
	Sweden	27,000	.....	.....	8,810,000
	Switzerland.....	38,950	.....	.....	12,612,650
	Spain.....	7,100	.....	.....	2,749,080

NOTE.—In this table the metric h. p. of 31,500 foot-pounds is used. The mark may be taken as 1s. or 25c.

Whoever has the interest to go more fully into the figures collected in the preceding tables will doubtless be able to gain many useful lessons therefrom. A particularly interesting comparison, for instance, is that of the natural sources of power of the various countries named with the value of the production obtained. Hastening, however, to the conclusion of my present remarks we come to a question becoming daily more acute: Where can we find the sources of power for our branching industries, more particularly for the young and rapidly growing electro-chemical industry? If we sum up the figures in Table III. this all-important fact stands out clearly against the conditions prevailing in the older industries—that, of the total of the power sources now employed or shortly to be used for electro-chemical purposes, 378,000 h. p. are obtained from water, and only 40,350 from steam and 2,520 from gas-motors, of which latter 2,500 h. p. are natural gas. This fact merits the greatest attention in judging the economic efficiency of a country. The older industry, almost in its entirety, feeds upon stores which, however plentiful, are a part of a more or less completed period of development of our globe, for which no material replenishing can be expected. The electro-chemical industry, on the contrary, to the extent of 90 per cent., is dependent upon working energies which are given us daily, but which, were it not for the physico-chemical technologist, would as continuously pass away with the passing moment. Indeed, their only purpose up to the present time, appears to have been the restoration, sometimes in very radical manner, of the hydraulic equilibrium of the globe disturbed by the sun.

STANDARDISING IN ENGINEERING CONSTRUCTION.

By Sir Benjamin Browne.

III.—LABOUR'S INTEREST IN INDUSTRIAL REORGANISATION.

N the introduction of standardisation into workshops where it has not hitherto been carried out—or, in fact, in any improvement of organisation or administration—to ensure success, it is necessary to have the hearty co-operation of the workmen themselves. It is all very well to say that an employer ought to be in a position to enforce his commands, to override opposition, and to insist on people doing what they are told; but everybody, who has thought at all on the question, must know that enforced obedience and unwilling service, even if secured (and it is by no means certain that they will be secured) are altogether a different thing from a cordial co-operation.

It has already been pointed out how necessary it is for the man who works a machine to have his whole heart and soul in the successful carrying out of these methods, and I tried to show, in the beginning of the second paper, that really a higher class of intelligence and character is required to carry out an elaborate organisation, than to make a single article of a first class quality by hand.

But how is this co-operation to be obtained? It is well known that there is a very large political party in England who hold very unsound views as to the interests of the working classes with reference to economy of production. Corresponding parties exercise more or less influence in other countries, though perhaps least of all in the United States of America. It is very often said by the leaders of the workmen that engineering manufactures are necessities, and that if a man wants a ship, and cannot buy it cheap, he must buy it dear—that, in other words, if only employers would stand firmly together to keep up prices, they might, perfectly well, not only pay the workmen higher wages, but make larger profits for themselves. Let them put up the prices of ships, engines, or machinery 20 per cent.; if they are all true to each other, it is said, the public will have to pay the price, and both the workman and manufacturer will be better off.

Now, we need hardly say that this teaching is as false as anything can possibly be. My only diffidence in putting it forward is, that

those who have not actual experience may be slow to believe that any large number of men can be found believing such utter fallacies; and the worst is that these ideas are not confined to the working classes, but are held by a great many Socialist theorists in a higher position. Perhaps even employers themselves have hardly thought out to what an extent this teaching is false. The fact is that, taken as a whole, there are very few manufactures which are so sensitive on the question of price as engine work, ships, and machinery, and few that will be so readily dispensed with by would-be purchasers, if the prices are not such as to give them complete satisfaction.

The object of standardising work is to ensure a definite level of excellence at a diminished cost. The first point generally commands the approval of the workmen, but they by no means always sympathise with the second. Now, to investigate the position, and decide whether they are right or not, let us ask ourselves, as a question of political economy: Whence comes the fund that pays for our engineering manufactures? For it is obvious that, before we know what the public will pay for our products, we must know what funds they have at their disposal and who are our real competitors in the spending of that fund. Most engineering manufactures will fall into one of three classes. First, the material of war. In this, probably, cost is not a matter of vital importance. If countries need defence, it may be said that they must have it; and although, probably, the ultimate limit spent by any admiralty or war office on ships and armaments is measured by the amount of taxation the country will bear, still there is, no doubt, a certain amount of toughness in the demand; and if the government thought that they wanted three or four more line-of-battle ships, the question of cost would enter only slightly into their calculations.

Secondly, there are necessary repairs and renewals. When a railway is at work, the traffic must be kept going. This applies also to a line of steamers, to a factory, to a colliery, and to almost all going concerns. Very likely all the work that comes into this category would have to be ordered, notwithstanding an appreciable increase in the cost of it. But when you come to reckon up the work that is done by engineers, and that which finds them employment, it will be seen that the two classes just mentioned form only a comparatively small part of the whole, and that what really keeps our large works going, and finds employment for our workmen—above all, that which creates a real demand for their services—is what may be generally classed as "new commercial work." Into this class fall all exten-

sions of our railways, all expansion in our fleets of steamers, all increases to our factories, workshops, mines, tramways, and the like; and the point to be observed in all these is, that nearly all the articles required for these purposes are simply purchased by the purchaser *for the purpose of making money.*

In other words, they are investments. If people make a new railway, or increase an old one, it is because they think the capital they so invest will pay larger dividends than they can get in any other available investment with equal security. If they put money into a steamer, that again is for the sake of the dividends; and so if they enlarge their factories, collieries, or anything else, it is all in order that the money so sunk may be to them a profitable investment.

Now, it does not need an employer or a specialist to know this. Any workman taking a superficial view of the work that is turned out in his district can satisfy himself on this point, viz.—that his business is to make dividend-paying appliances, and it is quite obvious that here there is no hard and fast rule as to what the world wants, or what it does not want.

Consider the case of railways. A capitalist finds that there would be sufficient traffic in a given district in Africa to bring in a revenue of £10,000 a year to a railway. About half that money would be required to work the line; the other half would be available for paying dividends. If he can make his railway for £100,000, the investors will receive at once 5 per cent. on their money, and this, coupled with the fact that they may fairly hope for future improvement, will very probably be sufficient to induce them to invest their money in this undertaking, and so to make large purchases of locomotive engines, rolling stock, rails, signals, and plant of various description, all of which gives work to the engineer at home.

But, suppose that these articles, and all the other matters that go to make the railway, increase on an average 25 per cent. in cost, so that instead of costing £100,000 the railway will cost £125,000; now where are we? The traffic is not thereby increased; the increased cost does not give the natives any more palm oil and ivory to sell, or any more blankets and hardware to buy. Therefore, there is still the same old £10,000 to divide as a return on the higher amount of capital. This means, in other words, that the proposed investor will only get 4 per cent. on his money, instead of 5, and he will probably say that, if this is the case, he had better invest his money in something else, and he will at once consider the merits of all the thousand-and-one investments that the stock exchange can offer him, besides

the merits of farming, house building, and other things; and I think the conclusion we should arrive at is that, whereas at 5 per cent. the money would be forthcoming, at 4 per cent. it will not.

The more we look into engineering works, the more this fact will force itself upon us—that the engineer is paid out of money which somebody wants to invest—in other words, out of money which somebody has saved; and we can, with perfect truth, tell our workmen in any engine works or shipyard that their existence, as a class, depends not on the necessities of the human race, but on the money which rich men have accumulated after spending all they want to spend. This may be a discouraging view, as it often is a very irritating one; but it is quite impossible to shut one's eyes to the truth of it. Suppose, for the sake of argument, that money was more equally distributed than it is, and that a certain £100,000, instead of going into the pockets of a few capitalists, was divided over the incomes of a large number of workmen; let us see where this will land manufacturing engineers. The first effect would probably be that the workmen, or at any rate the best of them, would live in better houses, would buy better clothes, eat better food, buy more books, and in such ways they would make more trade for the people who provide these matters. In other words, this might be for the good of the farmer, the clothier, and the shopkeeper; but it would, at any rate at first, probably be in only a minority of cases that they would save the money with a view to investment. A certain amount of it would be saved, but very much less than if it went into the hands of capitalists, and what was saved would go largely into houses and furniture, and not into what we commonly mean by investments.

If a rich man suddenly gets a large amount of money, he may spend a certain amount of it, perhaps a few hundreds, on his pleasure, but he is nearly certain to invest the many thousands with a view to future permanent increase to his income.

Therefore, if this £100,000 goes to a few capitalists, a very large part of it will go to make employment for engineers and shipbuilders, whereas if it is divided up, to increase slightly the income of a large number of people who are not able at present to spend so much as they would like, the first effect would be that they would spend it on their comforts, and of this only a very small part indeed would go to make work for engineering establishments.

Of course, a small amount would do so. For example, if more meat is eaten, it may have to be imported, and more ships are required, but the demand this makes is infinitesmal compared to what

the professional shipowner will do when he is beating up and working for trade in all directions for his own interest and profit, and I think I may fairly say that such bodies as are represented by the Amalgamated Society of Engineers, the Boilermakers' Society, and the other wealthy and influential unions connected with the engineering trade, would all be just about ruined, if we had a redistribution of property.

This may be a strong way of putting it, but it is based not on theory only, but on all experience; and there are so many people now who profess to be men of education and learning, but who mislead the working classes by socialistic writings, that it is quite time to put these matters plainly.

There is no more definite rule for the number of ships that sail on the Atlantic than there is for the number of cabs that can find work in the streets of London. Nobody can doubt that if cabs could be built a great deal cheaper, more cabs would be put on the road, and more work would be found for coachbuilders and their workmen. So it is with ships. A ship is nothing more than the packing case of the goods that come over in it. What the public wants is the cargo. What the shipowner wants is the profit on the carrying trade. Either of them wants the ship only as a means to these ends, and if ships can be built cheaper, the profit made by the shipowner is divided over a smaller amount of capital, and therefore there is a larger percentage; and, as regards the public, the cheaper the packing case, and the cheaper the mode of transit, the more are they able and willing to afford of the comfort or luxury obtainable from the cargo.

It is difficult to estimate to what extent a diminution in price will cause an increase in trade, but we have pointed out how many investments might be annihilated by a 25 per cent. increase in price, so we may fairly infer that if we could make a 25 per cent. reduction in price we should increase our trade very largely indeed.

Of course, the time may be coming, when the working classes will save more rigorously and invest more systematically; when they do, it will matter less to engineers which way the money goes, and the men who save will, to that extent, be members of the middle class, and will have taken a long step to efface the boundary that separates them from their employers.

It must be borne in mind that a very great deal of English capital is invested in engine and other manufacturering works in foreign countries, and the object of the manufacturing engineer, as a patriot, should be to try and keep this money at home. This can be done only by making the home investments more profitable, and the

way we can most often do this, as has been already pointed out, is by reducing the cost, and therefore the capital, over which the money earned in dividend has to be divided.

If what I have said is correct, it will be seen that disputes as to wages between employers and workmen are of very much less importance than questions as to restrictions of trade and management of works. Supposing half the cost of an engine consisted of the engineers' wages (and, generally speaking, it is less than this), a 5 per cent. rise or fall would only mean 2½ per cent. on the cost, whereas methods or policies which make men work in a less efficient manner may double, or treble, the cost of labour. The settlement of questions as to the difference between piece and time work, of the questions of a greater number of machines being worked by one man, and still more important, of the question of substituting machine for hand labour—these, and numberless other matters that are often in dispute in English workshops, are therefore far more vital than mere rates of wages.

It is probably the case that, if the workmen could see their way to throw themselves heart and soul into the views of the employers in trying to economise the cost of work, they could get, with little or no trouble, a very large increase in their wages, make very much larger incomes, and have much more permanent work, with employment for a much greater number.

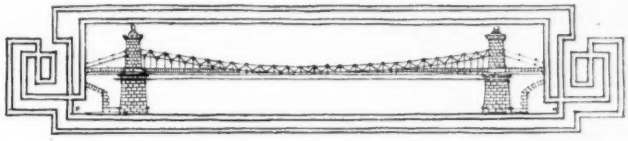
It is not fair to put the question of restriction down to trades unionism. The fault is in human nature, and we find it frequently among both classes and individuals who have never been connected with trades unions in their lives. Of course, the obvious effect of the trades unions is to cause the opinion of the majority to influence the minority more quickly than it would do otherwise, and where the opinion of the majority is wrong, this, of course, is a great pity; but, on the other hand, the unions must be credited with the abolition of many faults and vices which might otherwise still hold their own and flourish among considerable minorities of the community. The fault of trades unions, as of all other associations of human beings, is that they are inclined to be too despotic and to press their opinions too hard. It is possibly quite right and natural that men should combine and act together, but they ought to leave a fair margin for individual enterprise and individual experiment, among workmen as among capitalists. If a man is pursuing a suicidal policy, they would often gain more by letting the experiment be tried out without interruption than by stopping it arbitrarily.

The same arguments that apply against workmen's unions, and all dangers that appertain to them, are liable to apply quite as fully against the employers' unions, whenever these come to be permanently established; and there is no doubt they are gaining in strength throughout the United Kingdom every day. The joint regulations that are made between employers, as a whole, and the men, as a whole, frequently hinder an ingenious employer, or an enterprising workman, from trying something which he believes would be a success, and they certainly tend to stagnate and crystallise the customs of the trade and to destroy individuality. In so far as unions do this, they are, indeed, a hindrance to the development of the trade of the country; but if they were more enlightened and worked with more elasticity, it is difficult to say that they would do more harm than is done by that public opinion which exists in every community, and which so few men of any class or rank are really prepared to defy.

Standardising is, after all, one only of many ways of improving workshop economy; but it is a very important one, and no engineer in charge of works can consider that he has done his duty till he has studied the question carefully and carried it out as far as is possible.

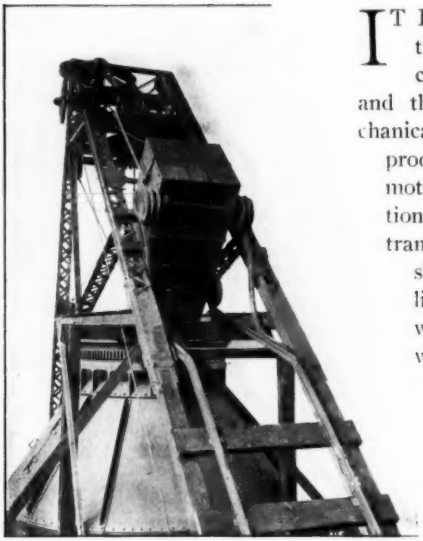
The readers of these papers may feel that, while much has been said as to the need of standardisation, comparatively little has been said as to its technical adoption. But that is exactly the vital point. Let its value be once recognised and its adoption desired, and no engineer will have any difficulty in finding out how to do it. The introduction must, like any other improvement, be somewhat gradual, and while each step is taken the next can be learned.

But, above everything, the improvement we most of all need is a hearty spirit of co-operation between workmen and employers. If we could bring this about, we should have no fear of foreign competition, and very little of bad trade.



MECHANICAL TRANSPORT APPLIANCES IN ENGINEERING WORK.

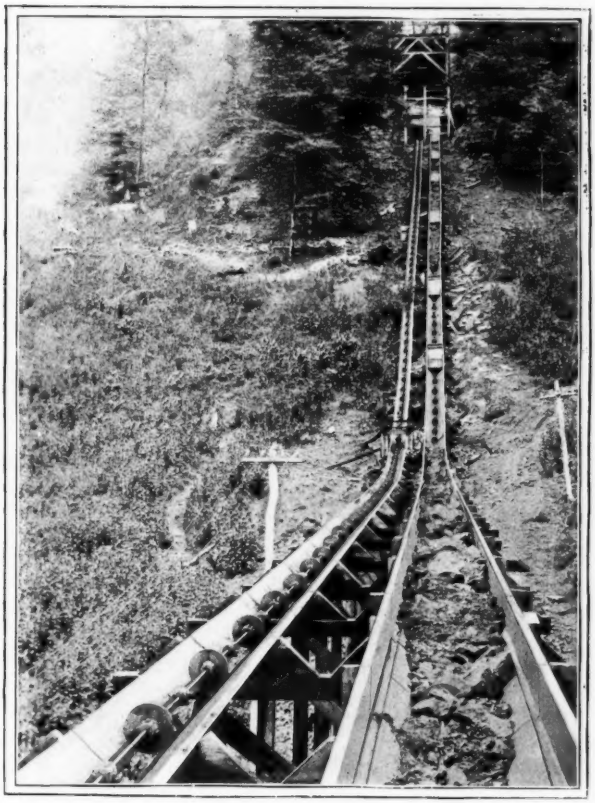
By A. J. S. B. Little.



A MECHANICAL FURNACE-FILLER.
Brown Hoisting and Conveying Machine Co.

IT IS axiomatic to repeat that the whole of industrial work consists in moving matter and that the advantage of mechanical appliances consists in the production and disposition of motive power; yet the introduction of automatic material-transmitters has been painfully slow in engineering establishments, and in other places where work is carried on and where materials have to be moved in their crude and finished states; yet power can be applied through machinery designed to economically convey, elevate, and distribute in every conceivable direction, with a reduced expenditure of money by the capitalist and of physical energy by the labourer. Despite the importance of labourlessly handling products, the means of accomplishing the desired end are imperfectly understood, and we must reluctantly confess that in Great Britain this fault is especially noticeable. We raise about 200,000,000 tons of coal a year (202,000,000 in 1897), which is shifted, say, three times before being consumed, making an equivalent movement of 600,000,000 tons of coal at cost of about 6d. a ton by hand and 1d. a ton by machinery; still only a small percentage of this coal is mechanically moved, the proprietors and managers who have the necessary powers being unaccountably conservative in abiding by the primitive methods which call for the use of barrow and

Engineering has been defined as the application of forces to the removal of materials. The limitation of any given undertaking is that of the cost which the results will justify. Mr. Roland, elsewhere in these pages, tells of the skill of the mechanical engineer in



RETARDING COAL-CONVEYING PLANT, LOGAN CONSOLIDATED COAL CO., MATEWAN, WEST VA.

The wire cable with attachments, operating over sheaves at top and bottom, replaces the tram system. It lowers run-of-mine coal, without breakage, over a distance of 550 ft., in a continuous stream, at the rate of 1,500 tons in 10 hrs. By the Jeffrey Mfg. Co.

shovel and concomitant waste of labour. Many reasons might be cited in explanation of this suicidal conduct, the main ones being want of capital at the disposal of proprietors, who are fraternally helped in their destruction by the inexperience, lethargy, or ignorance of the

cheapening and quickening mechanical manufacture. Mr. Little, in this paper and a succeeding one, shows how similar patient genius and concentration of study have enormously increased the power and lightened the labour of great engineering works—civil, municipal, mining, metallurgical—in fact, the entire range of constructive, manufacturing, and industrial effort. The field is so vast and varied that much must be told by illustration rather than by text. THE EDITORS.

working counsellors responsible for the healthful preservation of the firm's commercial life.

In handling coal from pit cages, the first operation is to size and clean it. This is best done mechanically with the aid of power-driven tipplers, fixed, jigging, revolving, and oscillating bar screens, picking tables where the splint is removed and the best coal delivered to trucks on railways, and conveyors to remove the small coal and deposit it in trucks on other lines of rails. Dirt conveyors may be placed collaterally or transversely with main belts, to take the slate

PUSH-PLATE CONVEYORS HANDLING COAL TO STORAGE.
The installation in the gas works of the Huddersfield Corporation has been in service more than six years, and is still in daily use. By the New Conveyor Co.

and dirt to trucks, and, where smudge from coal washers is not available, a conveyor may be used to feed small coal to stoker hoppers.

When collieries have a coal-washing plant in their vicinity a progeny in the form of a battery of coke ovens is sometimes the result of the successful union; in other cases it is found more profitable to work the ovens in juxtaposition to steel works. Experience proves that prosperity follows when labour-saving plant is introduced to feed the ovens, because the existing conditions are especially favourable to its adoption, the work being regular and sufficiently large to pay interest on a large capital expenditure.

The coal from the large storage hoppers is automatically fed by

THE LAKE SHORE DOCKS, ASHTABULA, OHIO, SHOWING ORE- AND COAL-HANDLING AND STORAGE PLANT.

The bridges are of 180-ft. span, 90-ft. cantilevers. The capacity is 50 tons per hour for each bridge. Brown Hoisting & Conveying Machine Co.

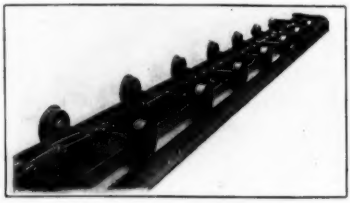
CONVEYING PLANT FOR COAL AND COKE.

Two elevators, side-by-side on the left, lift coal to storage. The elevator on the right lifts coke to trucks. New Conveyor Co, Ld.

soles tournants to a conveyor extending to the disintegrator, from which, in turn, the pulverised coal is fed to the bucket-elevator feeding conveyors over the second battery of hoppers at the end of coke ovens; small tipping trucks passing underneath take the material to the ovens; conveyors are also applicable for taking away the coke and raising it to a height from whence it can be shot into hoppers or waggons, as is done by the plant at the Carlton Iron Company's ovens.

Gas producers call for the free use of transport appliances. The most favoured method of charging them is by the aid of scraper conveyors and elevators feeding storage hoppers, while the ash can be removed to hoppers in the same manner.

To give an idea of the flexibility of these labour-saving appliances, which are to be seen working in all industrial establishments, we may say it is difficult for an engineer, who is *au fait* with the designs of machinery for efficiently handling materials and products, to imagine a situation where goods are being shifted, in which the operation cannot be performed by mechanical appliances. In the mineral centres engineers on the lookout for some system to ensure the regular working of their plant scheme to introduce a method of feeding the ore stamps, talc mills, coal trucks, brick-making machines, cyanide hoppers, lime screens, iron and other ore-carrying trucks and boats, caliche and calcined-ore hoppers, or whatever the particular requirements may call for; the miller charges his threshers and fills his sacks, or sends his grain in bulk to the enormous silos, where it is automatically stored and labourlessly picked up again for distribution to malt houses; there it is carried to cisterns, lifted into kilns, and afterwards carted to the breweries; there

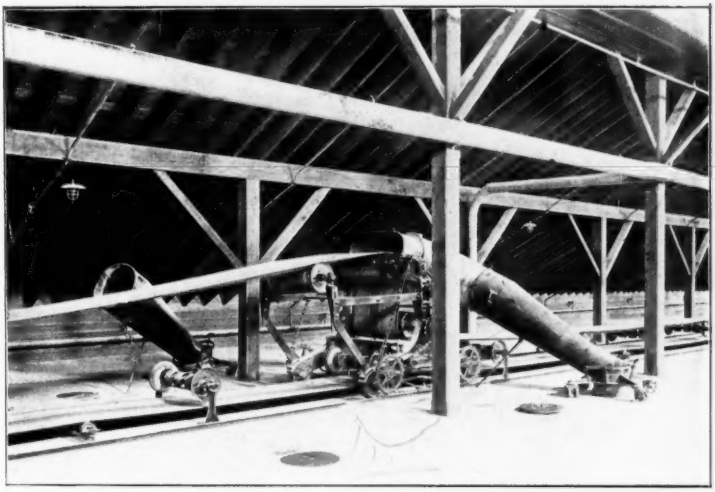


COMBINATION ROLLER AND SCRAPER CONVEYOR.

The scrapers have clearance at bottom and sides, and are carried by rollers outside the trough, thus avoiding noise. By Blake, Barclay & Co.

again it is transported and lifted, time after time, on its journey through the mash tuns and into the wet-grain tanks.

Candidates for municipal honours advocate destructors to get rid of garbage and other refuse, and, inasmuch as the one erected at Shoreditch is an improvement on the old sewage farm, so the feeding of the furnaces by elevators with 36-inch-wide buckets reduces the cost of handling materials and performs automatically what is otherwise a nasty labourious job. Take a look in at a gas works where the retorts are stoked by hand labour, and then visit a bench designed on the inclined principle, charged from overhead tanks filled by ele-



BELT CONVEYOR IN A GRAIN WAREHOUSE.

Manchester elevators. The tripping arrangement shown in position delivers the grain to any bin. Capacity, 5,000 bushels an hour. Webster Manufacturing Co.

vating and conveying machinery. In the former works the men have to weigh or measure the charge, wheel it to the retort mouth, shovel in the coal—and it is a difficult matter to ensure the even charging so necessary to obtain perfect carbonisation—then, after carbonisation they must rake out the coke and slake it preparatory to wheeling it to yard. Then the men hang their shirts up to dry. In the mechanically-equipped house, with a clear retort, the men close the bottom lid, pull a lever to open a measuring chamber and then shut the top lid. The machinery has already filled the tanks and measuring chambers holding about 7 cwt. of coal. After carbonisation the coke *slides*

CONVEYORS FEEDING COAL TO BUNKERS OVER INCLINED RETORTS, MEADOW LANE GAS WORKS, LEEDS.

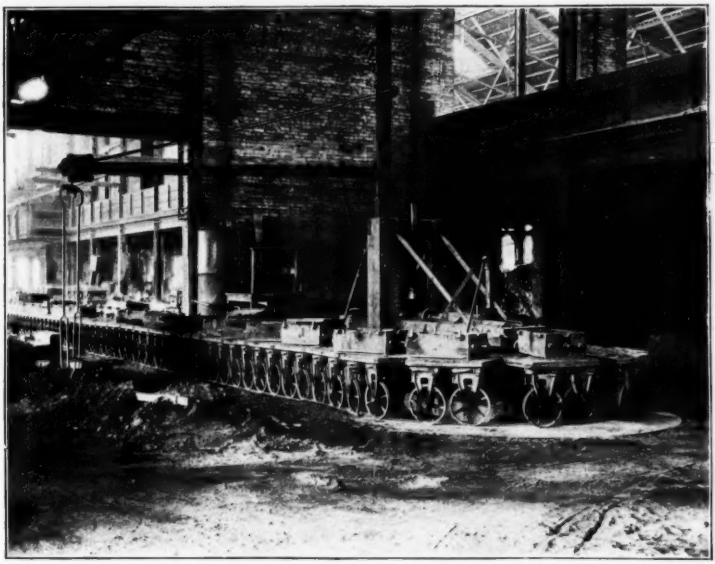
A similar installation is being put up to same designs at York Road, Leeds. The New Conveyor Co., Ld.

out of the retort onto a patent slaking conveyor which delivers into an elevator feeding a conveyor in yard. In the yard the coke is automatically screened, stored, measured or weighed, carted, trucked or bagged; apart from the saving in labour, the coke is more carefully handled, reducing breakage to a minimum and ensuring better selling prices. The workmen certainly score on this job and the company or corporation benefit by a saving of 1s. to 2s. per ton of coal carbonised.

In iron works, conveyors are now made use of to cast pigs at a reduced cost. This method makes it possible to tap furnaces at such times as may be found convenient, and ensures smooth and clean pigs of a uniform size and quality, and more homogeneous than those obtained by the older practice. The travelling moulds, made of ordinary Bessemer-iron castings, are connected to a double strand of chains; the iron is poured from the hot-metal ladles directly into a pot, which conveys the molten metal to, and distributes it over, the strands of moving moulds. Each strand consists of about two hundred and sixty moulds, and is about 125 ft. long. The moulds travel upwards on an incline of 9°, and are carried over sprocket wheels. The time taken to traverse the distance by any particular mould is about ten minutes. Dur-

ing this time the iron has solidified, and as they travel over the end the pigs are precipitated down two shoots, leading to a tank about 60 ft. long which contains just sufficient water to cover them. The pigs are carried through the tank on a conveyor, which, at the end of the tank, is carried around sprocket wheels, over which the pigs are precipitated into two shoots, discharging them directly into the waggons. Thus, unless for stocking, the pigs are never handled. With successive casts passing over the machine, the moulds are kept at a low red heat. To prevent the molten metal adhering to the moulds, they are coated with a refractory material on the return journey to the pouring pot by means of an ingenious spraying apparatus. A plant of this description on the Uehling system is working at the Millom and Askham Hematite Iron Co.'s works, and a number of similar machines have been long installed on the European and American continents.

In the November, 1897, impression of this magazine some useful figures were given relating to cost of operating wharf plants; to those who are specially interested in this class of work I would only add



FLASK CONVEYOR IN THE WESTINGHOUSE AIR-BRAKE COMPANY'S FOUNDRY.
The plant is at at Wilmerding, Pa., and is used in connection with moulding machine and cupola. Flasks from the machine are placed in the carrier, 225 ft. long, conveyed to the cupola for pouring, and, cooling in transit, are shaken out at farther end of the foundry. Link-Belt Engineering Co.

that the Ardrossan harbour in Scotland boasts some good machinery for loading and unloading sea-going vessels, on six or seven different principles, including a good railway-truck tilting arrangement.

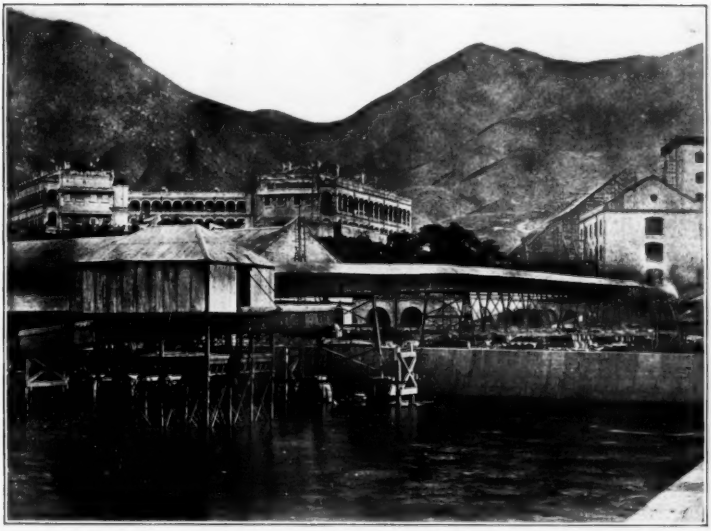
The Woolwich Arsenal has a plant for handling wood chips used in the manufacture of acetylene, and at a works in proximity to London conveyors are used to carry boxes through a heated chamber, wherein the labels on them are dried; a totally different system is in

CONVEYOR FOR KEEPING STRAIGHT THE STRAP IRON FROM THE ROLLS

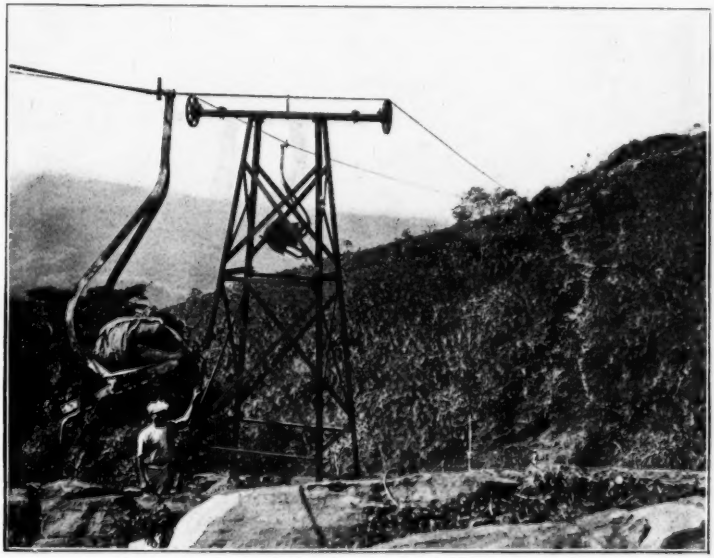
In use by the Union Iron & Steel Co., Youngstown, Ohio. The carrier is 106 ft. long and 6 ft. wide. Machines of like design are used as picking bands at coal-breakers, for which service they are run from 10 to 30 ft. per minute. Link-Belt Engineering Co.

operation in India to dry small coal which traverses a trough fitted with spiral conveyor built over brick furnaces. The Roburite Explosives Co. use a similar conveyor made with a jacketed trough to which live steam is supplied and thus the material is conveyed and dried; almost any material could be similarly treated. Paper pulp is automatically conveyed at Townsend Hook & Co.'s works, while Bazley White & Co. have utilised tray conveyors to feed cement crushers, and manage to pick out clinker from cement on its way to mill.

At St. Helens elevators are being erected to feed refuse to the furnaces put up by the Beaman and Deas Syndicate, the

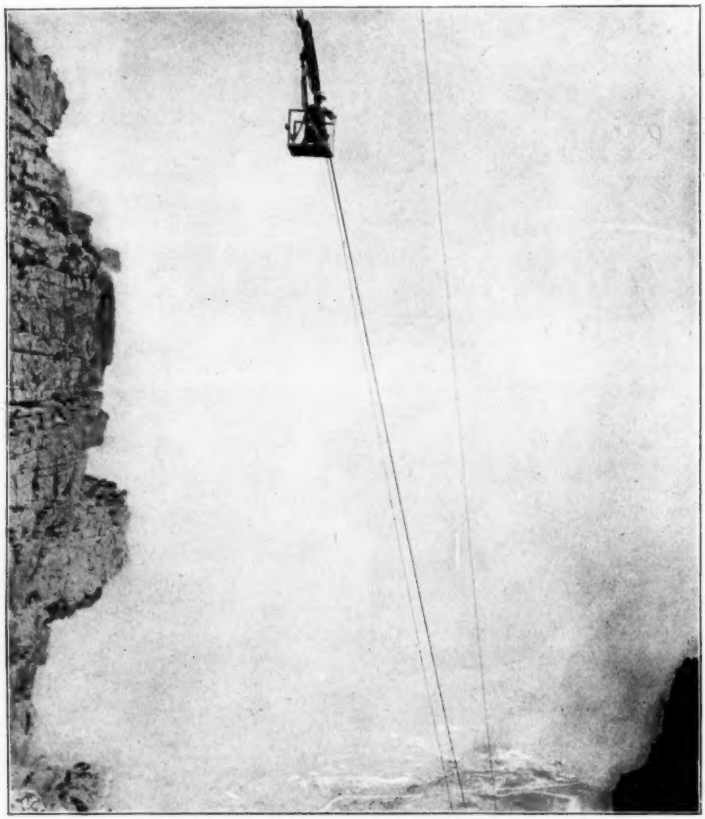


CONVEYOR FOR LOADING REFINED SUGAR INTO SHIPPING-OFF BARGES.
At work in the East. Made by Blake, Barclay & Co.



A ROPEWAY IN CEYLON.
The ropeway is three miles long, and is used for handling tea leaf. Bullivant & Co.

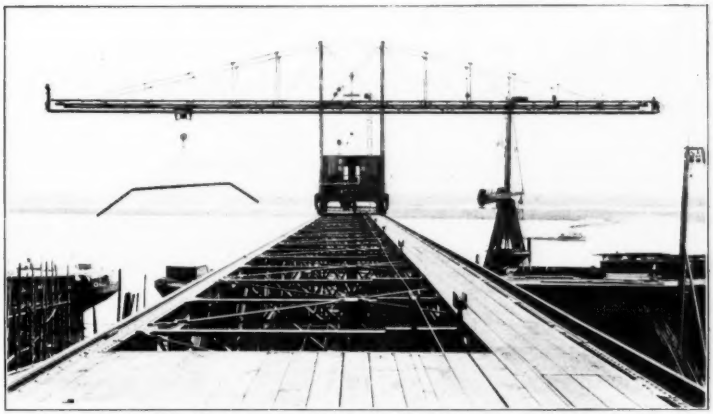
buckets being 36-in. wide and made to handle tin cans, mats, or any of the miscellaneous articles met with in the track of the night-soil man. Similar work is in progress for Aston, Birmingham and Hull, and it is certain that, apart from the money saved in capital outlay through the omission of inclined roadway and other adjuncts to the



LONG SPAN OF THE CAPE TOWN ROPEWAY.
The seashore, where the distant terminal is situated, is seen at the bottom of the picture.
This ropeway was installed by Bullivant & Co.

cart-tipping idea, a big annual profit will be secured to the undertaking on the resulting labour economy.

Most engineers concede that by the aid of automatic transport machinery, applied to works other than their own, enormous reduc-



TRANSPORTING CRANE IN CRAMP'S SHIP-BUILDING YARD, PHILA., PA.
Two more similar battle-ship cranes are under erection. The span is 202 ft. over all, the longitudinal travel 547 ft. over all. The speed of the entire crane with load is 600 ft. per minute, of the hoist with full load 250 ft. per minute.
By Brown Hoisting and Conveying Machine Co.

tions can be made in the cost of handling raw products, in the process of elaborating them into finished goods, and in the final distribution to points of consumption; but the harbouring by them of an idea

METHOD OF LOADING AND UNLOADING VESSELS FROM THE SHORE.
For use where rough seas, shelving shores, or infrequent business make piers undesirable. The main cable is permanently fixed to anchored buoy. Lidgerwood Mfg. Co.

concerning introduction of improved methods in the works under their management is found fatiguing. A stranger, walking through works and being familiar with installations of conveying machinery, notices situations which are peculiarly adapted to the introduction of such machinery, while the man in charge, having worked his system for years, considers it perfect. His first argument against reconstruction is "capital expenditure" and he erroneously concludes that a big outlay is needed. Secondly, he discourses on the inability to handle his material, ending by the stereotyped remark "You know it is a different thing handling this gritty and large stuff to shifting grain."

It may be surprising, but nevertheless is true, that for one plant designed to handle cereals automatically, hundreds have been adopted to work on minerals. In the chemical trade, for instance, plate belt

PULP-WOOD CARRIER AT THE INTERNATIONAL PAPER COMPANY'S WORKS, NIAGARA FALLS, N. Y.

The chain carrier in the foreground carries the wood from the water 150 ft. to the 500-ft. wire-cable conveyor which delivers it to storage. The mills, which are among the largest in the world, thus store during the season enough wood to carry them over the winter. By the Jeffrey Manufacturing Co.

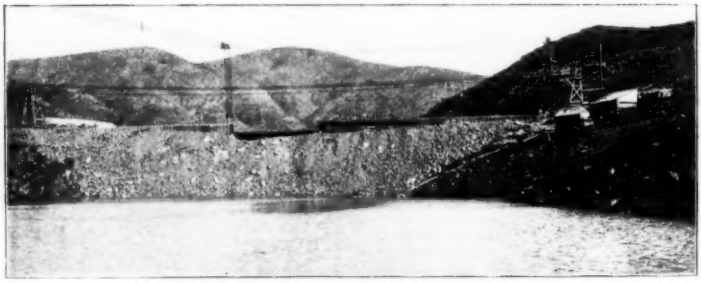
conveyors and elevators are universally used; one plant alone comprises fourteen elevators and conveyors, having an aggregate length of 1,500 ft., to handle phosphate rock brought in ships to quay side, conveyed to stores, and thence taken to mills and deposited into hop-

pers. Hundreds of small elevators are to be seen in the works of the United Alkali Co. and also in those of Brunner, Mond & Co., the Anglo-Continental Guano Co., and other large companies, while the smaller makers follow in their steps and dispense with the barrow and shovel as far as possible.

A VIEW OF THE WIRE-CABLE CONVEYOR DELIVERING PULP WOOD IN THE STORAGE YARDS OF THE INTERNATIONAL PAPER CO., NIAGARA FALLS, N. Y.

Steel works are well adapted to similar plant; here is it used principally for conveying coal, removing ash, elevating stone, carrying basic slag, etc. Hickmans Limited have a very complete plant for handling this last mentioned product, having erected separate buildings and fitted them with band-and-tray conveyors and elevators, which take the slag from the mill to the disintegrators; thence it is discharged through pipes to sacks situated over weighing machines. The only labour required is that necessary to tip the slag into the mill, and to tie up the sacks.

In the manufacture of screws and bolts, rivets, etc., the furnaces are fed with slack, the finished articles are removed to stores, and the swarf is taken from the sawdust with the aid of mechanical transporters. An arrangement in use at Miller & Co.'s works at Coatbridge feeds twenty-two rivet-heating furnaces, which heat the bars for forty rivet-making machines of an automatic type. The rivets are



CABLE TRANSPORTER IN DAM BUILDING.
Filling in a steel dam, Southern California Water Company, San Diego, Cal. 60 ft. depth of water. Lidgerwood Manufacturing Co.

made incredibly quickly. Coal is shot from waggons into elevators at 2½d. a ton, and the furnaces are worked by three men whose wages are 25s. a week, the conveyors being attended to by the man who oils the rivet machines. The conveying plant cost £700, and the cost of upkeep will be about £10 a year. The system gives entire satisfaction to the users, although it might be improved if an automatic truck-tipper were installed to empty coal automatically.

In the next issue of the Magazine I shall take up further applications of mechanical transport in the coal, iron, and steel industries, and the more distant carriage of materials by cableways.

TRANSPORTING CONCRETE FOR A NEW JERSEY DAM.
The cableway was used only for the concrete core. Lidgerwood Manufacturing Co.

THE STEAM ENGINE FOR THE ELECTRIC-TRACTION POWER-HOUSE.

By Charles Arthur Hague.

I.--PECULIAR PROBLEMS IMPOSED BY THE SUBTLE AND HIGHLY-VARIABLE LOAD.

THE rapid increase in the size and capacity of steam engine units for electric-power stations, until the ten-thousand horse-power mark is coming into sight—and indeed may be passed within a short time—illustrates, from a most searching point of view, the tremendous development of cities and towns, and the growth of the transportation problems involved therewith. Of course, the idea of large units carries with it the supplementary idea of enormous power-plants in the aggregate, until it has come to pass that the technical mind quite readily takes in and assimilates such items as 70,000 or even 100,000 i. h. p. under a single roof.

Nor is the mere size to which the steam-electric unit has attained the only striking feature of the matter. Seven or eight years ago, what is now known as the direct-connected dynamo had come into but limited use upon any scale at all, to say nothing of large capacities. Counter-shafting, belting, friction clutches, etc., were the thing; and a plant containing five or six 1,000- or 1,500-h. p. engines was a leader among its fellows, and not often to be seen. But with the gradual introduction of the dynamo mounted directly in connection with the main or crank shaft, the units could be increased with convenience and economy of space, to almost any desired extent. To-day, the three-phase alternating system of generating electric energy under high tension can no doubt be carried fully up to the limit represented by 10,000 h. p. in a single unit, by an appropriate arrangement of steam cylinders and crank shafts.

Probably there has never been known, for the steam engine, work of so variable a character as that of developing and furnishing power for a street railway; and when we get to operating what are now "steam roads" by electricity, making comparatively long runs on heavy tracks on solid road beds, the variable load represented by the passengers will be found to be much less, in proportion to the fixed load

Great advances in engineering come at times by some sudden epoch-making discovery, but more often by the patient genius of close concentration upon the conditions of a problem of work to be accomplished. Few, outside of the limited circle of those directly

represented by the cars themselves, than is the case in street-railway traffic.

In selecting a type of engine for street-railway work the extreme variation of load is a factor of great importance, and the choice must fall upon that type of engine which, under all of the conditions embraced in power-house demands, yields the best all-around economy in the long run and from the investors' standpoint. With steam engines, the higher the type with reference to multiple expansion the nearer generally must the most suitable conditions be followed. With a plain slide-valve engine controlled by a throttling governor, the widest range of work will affect the steam economy but slightly, if at all. With an automatic non-condensing engine, the lines must be regarded a little more carefully than with the plain slide valve, for best results. With the automatic simple condensing engine, with the exposure of the piston and cylinder walls to the low temperature of the exhaust, a wide range of duty still further interferes with economy of steam. With the compounds, and then up to the triples, quadruples, and to any higher plane of multiple cylinders, it will be found that the expected and promised economy due to the limited range of cylinder temperatures (obtained by cutting up into parts the complete expansion-diagram) can not be closely realized except by keeping nearly to ideal conditions for the particular type in hand.

The steam consumption of different types of engine is a subject of very great interest and importance; and when the range and variety in the service of different railroads can be made to point out, with fair accuracy, the type of engine best adapted to any case arising, then can the results of the adoption of this or that type and size of engine be foreseen. In a railway power-plant, the importance of looking into the value of an engine as an investment is greatly enhanced, of course, for the very reason that the conditions are complicated by the variations of load. The choice lies somewhere between a naturally-wasteful engine, whose economy can not be easily injured, and a very economical type of engine whose best economy can not be

concerned in the results, realise the enormous difficulties imposed by the traction power-house, nor the triumphant manner in which they have been met and surmounted by the engineers and builders who have devoted their efforts to this special problem. American practice has been peculiarly fruitful of opportunity for study of this question, and is rich in its fund of practical experience. A summary of the conclusions is of the utmost interest and value to everyone interested in the extension of electric traction. We are gratified at being able to present so authoritative a review as Mr. Hague's, and at thus falling into accord with modern engineering development by placing the stores of accumulated experience at the command of those who are making further progress. It is highly interesting, in this connection, to compare Herr Friese's paper on German practice and Prof. Carpenter's on American engine economy, reviewed respectively on pages 441 and 452 of this issue.—THE EDITORS.

maintained at all. This choice seems to point to the cross-compound condensing engine for units of 1,000 h. p. and upwards.

The variations in the power demands of street-railway work, as compared with the operation of an engine driving a flouring mill or under other steady demands securing practically the best conditions, are reflected in the difference in steam consumption probably about as follows for different types of engine, that for the steady load being taken at 100.

Type of Engine.	Steady Load.	Power-House.
Simple non-condensing	100	130
Simple condensing	100	145
Cross-compound condensing	100	125
Triple condensing	100	150

The cross compound does not seem quite to bear out the idea already set forth—of disturbed efficiency in relation to type; but the departure is favorable to the engine and its good results in power-house work are probably due to the fact that the cross compound is, practically, a simple non-condensing automatic engine at one side, working under good conditions in the main, in conjunction with a simple condensing engine having the advantage of a low range of temperature in its cylinder—making a happy combination of powers, loads, and temperatures, fairly consistent with the quickly and widely varying demands—especially if automatic regulation is employed with the cut-off valves for both sides of the engine. The question is sometimes raised of storage batteries and triple-expansion engines in connection therewith, permitting steady and constant operation of the engines at their best economical point; but so far the interest account, maintenance, and shrinkage of output, together with some tardiness in sudden and great discharges, called for at times during rush hours, seem to render those cautious who would become responsible for the installation of such batteries in large plants for furnishing railway power. Cheap money and dear fuel, together with some other items of more or less importance, are the friends of the storage battery most likely to force a readjustment of conditions, and perhaps to lead in the future to a partial sacrifice of some items just now held to be of greater importance in the general make up of the power-house account.

The adaptation of means to ends, where the means have consisted of all known types of steam engines, and the ends desired have been a practically uniform voltage under all changes of quantity, seems to have resulted in the choice, for large units, of the cross-compound ver-

tical condensing engine; and this seems to be the common goal of the engine builder in making sure of what he can accomplish with reasonable certainty, and also of the chief engineer, or manager or superintendent of the railway, in recognizing the best he can probably do under all of the conditions involved. This, of course, may be all changed in the future; but at present the matter of variable load seems to be the stumbling-block in the way of multiple expansion—especially so quickly sensitive and subtle a load as this. As the powers increase, more cylinders than two will have to be employed, even with the vertical engines; it is conceivable that eight cylinders may be used with a quarter-crank engine producing 15,000 h. p. in a single unit and still retain the compound engine. The trouble with the load varying from "all off" to 50 per cent. overload, is not so much with the total range of the expansion as with letting go of the steam too many times in passing and using it through several cylinders in a series; the compound simply taking it in giving it one squeeze and then passing it to another cylinder, squeezing it again and sending it to the condenser. This keeps the load close to the team, so to speak.

The question of speed or voltage regulation has been a source of anxiety to engine builders and electrical-power engineers; the secret seems to be, as much as anything, to have the engine well in hand and under close limits of control—or, in other words, to drive the team with moderately taut reins after harnessing it rather closely to the load. The combination of throttling and cut-off regulation promises something in this direction; but perhaps the haunting spectre of "close regulation" of speed has kept back something better. If what is wanted in supplying the current is a uniform voltage, combined with a variable flow, perhaps the exacting requirements so often held to are not, after all, the real requisite. Every water-works manager, dealing with the supply of water through pipes, would have, if he could get it, absolute uniformity of pressure with the quantity varying to suit the demand; this would call for just the opposite to uniformity of speed, because uniform speed in a pumping engine would give constant quantity and variable pressure. So, with a constant voltage and a varying product of volts and amperes, what is wanted is the engine which will preserve the balance—even if we do have to overcome our habit of thinking about cotton-mill spindles and flour-mill rollers, picks to the inch and pounds to the bushel. The work of the cotton mill is 1,000 spindles or 5,000 spindles at uniform speed for the uniform spinning, the variation of power being due to the variation in the number of spindles. But the cotton mill was with us first and had wedded to-

gether uniformity of speed and variableness of power to an extent which makes necessary an effort in the breaking away from it. But conservatism commits less errors than radicalism, so we must get a fairly good hold of one rope before we let go of a well-tried one. But it may be that correct voltage will be a better term than constant voltage; in any event, why not regulate the engine with the proper voltage in view, and regulate by the voltage itself, regardless of speed?

Still another legacy, from a different steam-engine practice, is the absolutism of demand for a perfect indicator card. In sheer despair at our efforts to retain the immaculate diagram, we will some day make a concession at the best point of compromise and suddenly wake up to the fact that we are more strictly scientific than ever before in obtaining control and regulation of the steam engine. In fact, the practice of throttling the initial steam for very short cut-off and, in combination therewith, varying the point of cut-off further out in the stroke with the full initial, has already entered the field; and this line of action, to which the steam engineer has been driven against his stubborn will, may possibly open the door for a longer line of multiple expansion under greatly variable loads. Some time ago I became interested in investigating the propulsion lines of a proposed triple-expansion engine for electrical-power development, and, after various experiments, followed the line of throttling the "peak" of the high-pressure diagram; regulating the cut-off automatically on the intermediate cylinder and having a fixed cut-off pretty well out on the low pressure. The resulting development of propulsion, under widely variable loads, was a strong appeal for the triple engine in power-plants—with apparent promise of holding the variation in steam consumption within the lines of the compound and, at the same time, giving a higher actual steam economy. This idea, carried out on large engines, would give twelve impulses per revolution and an angular velocity of the revolving fields closely approaching uniformity.

After we have been forced to make a concession to laws of nature which, at first, were not recognized, it is generally found that the inexorable facts in the situation were merely asserting themselves for the consistency and betterment of the scheme in hand. This, applied to the combination of throttling and automatic-regulating, will show that the tendency is to keep the mean effective pressure near to the middle of the stroke, instead of developing the m. e. p. so near to the initial end of the cylinder, and without a doubt the lessened tendency towards cylinder condensation will offset the slight loss in expansion involved. Upon the other hand, after the steam is holding

its initial further out in the stroke, and the throttling effect tends to locate the m. e. p. too near the terminal end of the stroke, then the removal of the pressure restrictions will tend to hold back the m. e. p. nearer to the mid-stroke, the range of temperature being kept down by the lower ratio of expansion. This all means a closer approach to uniformity of temperature within the cylinders, and a more constant relative position for the m. e. p. in the stroke. In applying this idea to a triple-expansion with a strictly automatic cut-off in the high-pressure cylinder, with, say, 165 lbs. absolute initial pressure, happening to cut off at a point giving five expansions, there would be an absolute m. e. p. of 86 lbs. and a terminal of 33 lbs. But by maintaining the same m. e. p. and by throttling the initial 12 per cent., the cut-off would have to go out to a point giving four expansions and the terminal would rise to 36 lbs.; then the automatic cut-off on the intermediate would provide a balance of power and deliver a constant volume of steam to the low-pressure cylinder at a slightly varying pressure, which, with the practically constant vacuum and fixed cut-off, would go far towards holding the engine under control—like the handling of the team under taut reins. A sudden overload would result in quickly raising the initial and letting out the cut-off on the high-pressure cylinder, and the automatic cut-off on the intermediate would bring the machine under conditions somewhat resembling those of the cross-compound in the moment of need; in other words, the low-grade and the high-grade engines would be combined to meet the extraordinary demands when the need came, and then relapse automatically into a state of high economy when the load permitted.

The general statement of the problem is sufficient to indicate its peculiar difficulties, and the extent to which its solution must be found in wide departure from practice based upon experience gained in other lines of steam-engine design and construction. In the next issue of this Magazine I shall review, concretely, the form which modern practice has assumed in typical large installations—both as to general arrangement of the main and auxiliary machinery and the proportions and constructive features of the engines themselves.

EDITORIAL COMMENT

The immediate result of the conclusion of the war in South Africa will be new stimulus and freer scope to the mining industry—itself a matter of huge magnitude and importance. The further and greater consequence will be a tremendous advancement of the vast schemes for African industrial and commercial development, of which Cecil Rhodes is the genius and of which the Cape to Cairo railway is the central system. It is an imperial project—but the Empire is economic, not merely political.

* * *

One of the objections which has been urged against the automobile is the fact that horses and other animals are apt to be frightened at the mechanically-propelled vehicle. While this objection is more fancied than real, it may well be worth considering whether a source of traction which can be so readily frightened is not the one against which discrimination should be made. If the horse does not like the automobile, so much the worse for the horse.

* * *

In some cases the importance of having a motive power which cannot be frightened must be conceded. In the recent battle near Ladysmith it appears that the reverse to the British arms was due to the stampeding of the mules attached to the ammunition trains, the troops being thus deprived of ammunition at the critical moment. While it is by no means certain that mechanical traction could have been used instead of the nervous mule in this particular case, yet there is every reason to believe that, in very many instances, artillery and supply trains could be hauled by machinery with perfect success, and certainly stampeding would be impossible. It may be that designs suitable even for rough country can be made, which will altogether replace horses and mules in the work of hauling, and the advantages to be gained may be worth considering.

* * *

John Graham Brooks' able review of the Trust craze in America, which we present this month, will be read with interest and profit by thoughtful men throughout all branches of engineering industries. The publication affords us special pleasure because of his strong advocacy of publicity in regard to the affairs of all great corporations. The courts, the banks, the stock exchanges, the newspapers, and students of public policy everywhere have at last been aroused to see that the sovereign remedy for the shameless abuses attending Hooleyism in England and the Trust craze in America is "to turn on the light" and to give every stockholder the right to know all about every company whose shares are offered in the open market.

And what Mr. Brooks says upon the pressing need for better organisation of American railroads, municipal works, and, in fact, public-service corporations of every kind, is absolutely true. These enterprises, now in pri-

vate hands, must have better organisation and better management, or public demands, led by political demagogues, will land them all in the hands of the State. And when a Republican form of government is confronted by government ownership of railways, and municipal ownership of water works, gas works, electric-lighting stations, and tramways, it is on the highway towards the state socialism which lowers threateningly over so large a part of continental Europe.

But while we agree with him cordially upon the great need for publicity and the necessity for better organisation, we stoutly dissent from the idea that the combination scheme as illustrated in America can have any permanent place in the organisation of manufacturing industries. The great Standard Oil Company has succeeded thus far because nature limits the supply of oil. In like manner the production and price of coal might be controlled, because it is practically a question of acreage. But in manufacturing industry there is no such fixed limit. In the cordage industry, in the production of whiskey, and in rubber manufacture, actual experience has already demonstrated that these combinations cannot permanently control prices, production, or competition. The combinations, in fact, simply stimulate competition, because able men outside the combinations are quick to see that the chances for making money are greatly improved by the mere fact that, in the beginning, combination steadies prices and rids the market of foolish competitors. What we may confidently look for, therefore, is the disintegration, either gradual or sudden, of these stock-gambling ventures, with heavy losses to investors in their shares. Meanwhile, good managers throughout all lines of manufacturing will build surely and strongly while these speculative amalgamations are passing through the rigor of reorganisation.

"The survival of the fittest" is the inexorable law of the industrial world.

* * *

Many apologists for the British manufacturer, in the matter of the contracts recently placed in America, have laid stress upon the part played by overpressure of work in excluding from British works the undertaking of new orders—at least for prompt deliveries. Mr. Slater Lewis, in his excellent contribution to this issue, revives and greatly magnifies this argument. But it is evident that overpressure of work in hand may come from either of two causes—abnormal demand or subnormal ability to meet it.

Whether or not the policy of intensification and specialisation—which is regarded as characteristically American—gives more elasticity to productive capacity is now in a fair way to practical test. The pressure upon the machinery trades of every sort in the States is at present apparently as great as that which has borne upon English manufacturers for several years past. The fact probably is that the needs of the world are so vast as to demand the maximum output of all mechanical appliances and engineering tools. Probably, also, England has long supplied more than her share of such products. The share still seems to be more than she can well supply. There seems small need for her manufacturers to complain, though they are wisely alert for any means of augmenting their capacity.

REVIEW OF THE BRITISH PRESS

Technical Discussions.

EVERY one admits the great value to the engineering profession of the periodical gatherings of the great societies, and realises the importance of the papers which are presented and the discussions which follow, and those who appreciate these features the most will also take much interest in reading a recent editorial in *Engineering* upon the subject of technical discussions, criticising most effectively some of the shortcomings of such meetings.

With the papers which are presented little fault can be found, and often much praise is elicited, and this is only natural when it is realised that contributors to transactions generally treat of subjects concerning which they have had special experience, and give time and care to their presentation. At the same time, however, it is from the discussions that the greatest advantage may be derived, if these are but carried on in a proper manner.

It is practically impossible to predict the kind of a reception which a paper may meet. In some cases an apparently colorless paper, devoted in the main to matter-of-fact description, has set on foot a topic which has led to keen controversy, while, on the contrary, an elaborate paper dealing in great detail with matters on which strong and widely opposed opinions are held, has elicited little or no comment.

"In spite of all the good speeches which are made, it must be confessed that the average of oratory at technical meetings is low. There is, in general, no lack of speakers, and neither is there lack of knowledge; but it often happens that the men who speak do not know, and the men who know do not speak. In addition, we have the man who both knows and speaks, but cannot express himself to any purpose. It is often a wearisome business to sit while one member after another struggles with his ideas, or his want of ideas, and one thinks what an advantage it would have been if the speakers had taken the trouble to commit to paper beforehand what they wanted to utter." This lack of preparation is one of the great evils of discussions at these meetings. Often the discussion is turned toward some side issue, the main question being entirely ignored, and much of the labor of the author of the original paper in gathering facts and preparing to meet possible queries, is wasted.

"If half a dozen men had come with their minds fully made up on that part of the subject with which they were best acquainted, such a thing could not happen, for each would raise a definite issue of importance, and there would be some real and valuable criticism."

This matter of written preparation may, however, be carried too far, and it must not be inferred that immediate and spontaneous discussions may not frequently be of the greatest importance and value. Some of the most important points in a discussion are elicited, not by the original paper, but by the remarks made by a subsequent speaker, and when a real contest of wits backed by real ability and experience is provoked, some of the very best of technical discussions are the result. Unfortunately this does not occur nearly so often as it should. As the writer in *Engineering* truly says:

"The good speeches which are never heard exceed in number those which are heard. How often one feels, in looking around the benches, that there are several silent members who have a knowledge of the subject in hand far beyond that of the speakers! Diffidence holds them back; their very familiarity with the subject leads them to take a depreciatory view of their knowledge, and, besides, they are not prepared. If they had only taken the trouble to put their ideas in order, to search their stores of recorded information, and to crystallise the theories which—perhaps unknown to them—dominate their practice, they might have taken a most useful part in the debate, adding credit to the society, and gaining reputation for themselves. Technical societies would enter on a new career if the members would carefully scan the programmes of

forthcoming meetings, and would procure copies in advance of papers dealing with subjects which they understand, with the intention of confirming, or controverting, to the best of their ability, the statements which they contain. It is no slight labour to write a good paper, and such an effort deserves far more recognition than a perfunctory vote of thanks. The writer lays his stores of knowledge before his associates—often before his rivals—and it is a poor spirit which is content to make no return when the opportunity arises.

The Progress of the Steam Turbine.

EVER since the success of the Turbinia there has been much interest evinced in the steam turbine, both in its application to marine propulsion and to the driving of electric generators, and hence the paper of Hon. C. A. Parsons presented at the recent meeting of the British Association demands especial attention.

The paper was intended to be an account of the performance of the torpedo boat destroyer which has recently been fitted with turbine machinery of exceptional power, but unfortunately the completion of these trials was interrupted by damage to the destroyer by collision, and hence only a portion of the preliminary information was available in the preparation of the paper.

So far as the trials have been conducted they show a very satisfactory performance, both as to low steam consumption and freedom from vibration, and when operated under full designed power there is every reason to believe that the guaranteed speed of 35 knots will be attained.

It will be remembered that the Turbinia made a maximum speed of 34½ knots, and did so with the low steam consumption of 14½ pounds of steam per i. h. p., and the measurements so far recorded on the new destroyer seem to justify the expectations of a greater degree of economy in the turbine engines of the destroyers than in the smaller engines of the Turbinia.

The main object of Mr. Parsons' paper, however, was to demonstrate the practicability of constructing larger vessels for turbine propulsion, especially fast steamers for crossing the channel. The advantages of the steam turbine for fast passenger service are obvious. The steam consumption is no greater, indeed is probably less than that of triple expansion engines of equal power, while the total weight of propelling machinery with the turbine system is under one-half that of ordinary screw engines, and under one-third that of paddle engines. Owing to the absence of reciprocating motion there is little or no vibration, and as there is no need of bracing against racking stresses the hull may be made lighter than is now possible. Since no lubricant enters the steam part, the condensed steam is free from oil, and express water-tube boilers of the smaller-tube type may be maintained in satisfactory working conditions for long periods. The smoothness of motion, and the absence of racing, due to the depth of immersion of the propellers, will add greatly to the comfort of passengers, and the increased speed will shorten the voyage materially.

Mr. Parsons has prepared plans for a fast channel-steamer of about 1,000 tons displacement, which, with steam turbines of 18,000 h. p., should make a speed of 30 knots, and if such boats were placed on the Dieppe-Newhaven line it would be the fastest route between London and Paris; while on the Dover-Calais route they would shorten the time by half-an-hour. Two designs have also been prepared for transatlantic steamers on the turbine system, one of 18,000 tons displacement, and 38,000 h. p., which should attain a speed of 26 knots, another of the same displacement, but of 40,000 h. p., by which a speed of 40 knots would be made.

The steam turbine has now been in practical service long enough to reveal any radical defects in its design if any such existed, but experience gained in the trying altogether encouraging. In the station at Cambridge it is stated that one steam turbine has run for a year without attention, and that it was in as good condition at the end of the time as when it was first put to work. At that portion of the blades where it was predicted that serious erosion would occur, the file marks were still plainly visible on turbines which had been at work for six years.

There seems to be little doubt that the principle of the turbine is thoroughly established and that, as Mr. Parsons says:

"It is an ideal rotary engine without reciprocating parts, with a uniform turning moment and almost complete absence of vibration, and of extremely small weight." When to this is added a working steam consumption of not more than 15 pounds of steam per h. p., it will be seen how strong are the claims of the motor for marine and electrical service. The completion of the trials of the torpedo-boat destroyers will be awaited with interest, and if the anticipations raised by the preliminary trials are realised there should be no difficulty in procuring the construction of the channel and ocean steamers which have been already designed.

Locomotive Building in England and America.

IN a recent isues of *The Engineer* the locomotive trade of Great Britain is discussed at length, and incidentally the methods in vogue in England and the United States are compared.

Until recently, the greater portion of the products of the American locomotive works has been for home use. In England, on the contrary, most of the railway companies build their own engines, and the private locomotive works have been occupied with export trade. Since this trade is of a widely varied nature the builders have been obliged to comply to a very great extent with the special requirements of the customers, and the methods of construction have been affected accordingly. A large portion of the foreign trade of the British locomotive works comes through civil engineers. "In other words, Great George Street gives out the orders." In the United States, it is true, the locomotives which are built by private works for railway companies are built under careful inspection, but this is reasonable inspection, while much of the inspection in England is unreasonable.

Then again the greater efficiency of workmen in the United States is an important factor. At the Baldwin Locomotive Works it is said that one engine can be turned out per annum for every five men employed, or with 5,000 men 1,000 engines per annum will be made. In England, on the contrary, the output is about one-half this. A part of this increased efficiency is due to the men, part to special tools, and much to the fact that there is no interference with a man who does more than the rest of his fellows may have elected to consider a day's work.

Much of the cost of English work is due to captious and unnecessary strictness of inspection, requiring alterations and reconstruction where such are altogether unnecessary, merely to satisfy the whims of the engineer who stands between builder and purchaser. This adds not only to the cost, but also to the time required, and this system has had much to do with the length of time required by English builders to fill the orders which they have taken. The American builder, on the contrary, goes directly to the customer, agrees to give him results and takes the responsibility for the means by which he accomplishes them, and, freed from the trammels which hamper his British competitor, he is able to beat him both in cost and time. The English builder may expatiate on the high character of his work, and contend that absolute perfection of workmanship is essential in order that a locomotive may be durable. "The American asks, and asks very wisely, what is the use of building locomotives to last thirty years, which will be wholly superseded and out of date in ten, or perhaps five years."

Great Britain cannot expect to supply the world's demand for locomotives with her present facilities, and if those facilities are not extended other countries will certainly enter the field.

"In this way, and in this way only, is United States competition likely to be dangerous, and its attacks can be parried by adopting American methods. It is beyond question that the older country has much to learn from the newer country. The real danger is that we shall refuse to learn. If Americans can build engines which will do the world's work sufficiently well by the hundred, while Great Britain is turning out only by the dozen, models of mechanical perfection intended to be of use by our grandchildren, we must rest content to stand on one side, and let our rivals go ahead. American engineers do not build for posterity. They think of the present, and leave the future to provide for itself, and the enormous success of their country is largely due to the concentration and grip which is a necessary concomitant of this policy.

Bacterial Treatment of Sewage.

In view of the interest which has been taken of late in the bacterial method of purifying sewage, the second report of Drs. Clowes and Houston to the London County Council upon the work of the purification beds at Crossness is important.

The principal information given by this report is the action of coke beds upon sewage, especially in the case in which the fragments of coke are as large as walnut size. Three beds, of 4, 6, and 13 feet in depth, have been subjected to careful working tests, the results on the first two extending over a period of about 10 months and on the third, for about 9 weeks. Through these beds the crude sewage as delivered at Barking and Crossness is passed, and the results of careful chemical and bacteriological examinations before and after the operation are collected and exhibited in the form of diagrams.

The general process is to allow the raw sewage to flow on to the surface of the bed and to remain upon it for about three hours, after which it is slowly drawn off and the bed allowed to stand empty for eight hours in order to permit the coke to become aerated. Twice a week the surface of the coke is raked over, to keep it open, otherwise no manipulation appears to be necessary. The coke does not appear to become foul or display a tendency to break up, and the principal changes which take place are the partial covering of the pieces with a soft matter consisting of particles of woody and vegetable tissue with some fine sand, while the ash is reduced by about 25 per cent.

A single treatment of this sort removes 51.3 per cent. of the dissolved oxidisable and putrescent matters, and all of the suspended matter, and the effluent remains free from objectionable odours when kept in open or closed vessels, and is not injurious to fish.

The treatment does not appear to remove the bacteria from the crude sewage, and while the presence of many bacteria is doubtless unobjectionable and probably necessary for the completion of the purification of the effluent after it has passed into the stream, doubtless some pass through which would be objectionable in drinking water. This shows, in the words of the report: "that the coke beds were highly efficient from the point of view of solution of suspended organic matter and a partial destruction of dissolved and offensive substances, and as a preliminary measure tending in the direction of complete disintegration and ultimate purification of the crude sewage, but that they were unable to bring about the complete resolution of the organic matter."

This brief abstract shows that the use of the simple coke bed will at least enable sewage, originally foul, to be delivered into a stream without rendering it in any way objectionable, and streams which must receive sewage-discharge may at least thus be prevented from becoming open sewers. It is more than probable, also that a further purification takes place after the discharge of the effluent, and water from such streams would need only slow sand filtration in order to be rendered fit for drinking.

As the report is not offered as a final one, and as the tests are to be continued, we may look for more information from this important installation hereafter.

American Competition.

Although much has been said and written about the competition of American manufacturers with Englishmen in fields where until recently the latter have had supreme control, there has nowhere appeared such an exhaustive discussion of the matter as that which has recently been published in the columns of *Engineering*.

This series of papers, written by a number of prominent English and American engineers, may be considered as a symposium upon this important subject, entirely free from prejudice or animosity, covering the field from the view-point of the engineer and manufacturer in a manner which cannot fail to interest and instruct the parties most directly interested on both sides of the Atlantic.

In the first place all the writers assume without question that the competition of Americans with British industries exists, that it is increasing, and that if something is not done to meet it that many English markets will either be lost entirely or divided with the successful competitor. The reasons for this recent invasion into British commercial preserves are variously at-

tributed to causes more or less apparent, as the following quotations will indicate.

So far as the influence of the British workman as such, is concerned, Col. Stevens says: "The English workman is the equal of any, but not if he is in England." His principal reason for this statement is, that in America the workman's ambition is absolutely uncurbed, and that therefore he is willing to co-operate in methods for increasing output and reducing piece-cost if he can thereby improve his own position. Says Mr. William Kent: "What of the English workman? He has a fundamental fallacy implanted in his brain to the effect that the total amount of work done is a limited quantity, and if he does too much in a day, or obtains the help of a machine to do more than he has done, there will be less work for him to do to-morrow or else he will be reducing the amount to be done by his fellow workman." Again, Mr. John Thomson quotes: "The chief trouble with foreign mechanics is that they know only one branch of the business, which is due to the laws of their trade unions, which in many cases prohibit the working or running of more than one machine; hence they learn only one branch of the business. This is especially the case with the English trade union mechanic."

Turning now to the British employer, his conservatism is held to be largely responsible. "It must be admitted that we Britishers have our prejudices, and so strong are they very often, that we stubbornly stick to old methods when newer and better ones have been discovered." This from Mr. George Howell. In like manner Mr. William Kent says: "England's trouble with American competition to-day is not due to any fault of geographical location, nor to any failure of natural resources. It seems rather to be due to the natural peculiarities, or to the prejudices of her people." An anonymous English contributor to the symposium says: "The Englishman is too conservative to willingly try foreign methods. Until recently the average Englishman was profoundly ignorant of what was being done abroad, and was unwilling to believe any statement which he had not verified with his own eyes." Mr. John Thomson shows that the characteristics which have made England a leader in the world's industries have also acted to retard her progress. "The condition indicated (*i. e.*, her present high position) has been largely produced or made possible, from those splendid British characteristics, tenacity of purpose, perseverance, stubbornness, patience, loyalty, respect for usage, and maintained performance of duty according to conscience or under orders. These attributes, when applied to new fields of progress, mean slowness of change from existing methods; more or less of defiant, crusty opposition to modification; satisfaction with that which has been accomplished in the past, and stolid confidence, or indifference, as to the results of the future."

Thus much from the side of causes acting in England. Turning now to America, we find that practically the opposite conditions have existed. Speaking of the American workman, Col. Stevens says: "He recognises that he can aspire to almost any position; that ability is quickly recognised, and that, a journeyman to-day, he may to-morrow become a foreman, and a proprietor the next." Mr. Kent remarks: "There is no tendency to reduce the daily wages of labour in American machine works, but on the contrary, the tendency is to advance them. The piecework system is used to a great extent, and the workman does not object to tending two or four or six machines, if he is able thereby to increase his daily wages." Again, the same anonymous contributor before quoted, says: "In America the harder a man works the better he is paid, and there is little time or inclination for loafing." Everything has thus acted to limit the productiveness of the workman in England and to increase it in America.

The progressiveness of the American proprietor is well-known, and so far from pointing with pride to a machine which has been in use for more than 90 years and tended by three generations of the same family, he endeavours to drive his machines to death, in order that he may get the full value out of them before they become obsolete.

Nearly all large English works are managed by elderly men, whose great capacity is admitted, but whose opposition to change is also well-known; while in America man-

agers are usually much younger, and are constantly on the lookout for improved machinery and methods.

Taking these general abstracts as typical of the whole discussion, we have the summing up of Mr. Thomson:

American industries are able to compete successfully with those of Great Britain: "because of better organisation; more complete adaptability of system; greater incentive; a higher, or broader, development of engineering as a profession; ready flexibility to meet new conditions, and because low-priced craftsmen in Great Britain may, and do, more quickly become high-priced master workmen, or foremen, or superintendents and proprietors, when transferred to America."

Tramways in the United Kingdom.

In view of the rapid progress which has been made in electric tramway construction and operation in other countries, and the backwardness which until very recently has been the condition in Great Britain, an article in the *Tramway and Railway World* upon the early future of electric tramways in the United Kingdom is of much interest.

There are two lines along which development may be expected. The first of these naturally is the conversion of existing roads. About one-fourth of the 1,200 existing miles of tramway in the United Kingdom are at present operated by electricity, and, so far as the populous centres are concerned, from five to ten years' time will probably see at least three-fourths so equipped, and probably most of this will be on the overhead trolley system. Where the existing owners are unable or unwilling to make the change, others stand willing to do so when allowed, so that there seems every prospect of a speedy end to the horse as a motive power for tram-cars, a consummation devoutly to be wished on the score of humanity, cleanliness, and economy.

The re-equipment of existing lines, however, forms only a portion of the construction which may be expected, and there ought to be, and in all probability will be, almost as much progress in the direction of new lines and the extension of old ones as in the change of power for the present tramways. The amount of work involved in this transformation is very large, and an estimate of its value will be of interest. Taking the present mileage already equipped with electricity, or very shortly to be so operated, and assuming the low cost of £8,000 per mile, we have a total of £2,800,000, or in round numbers £3,000,000, and this will doubtless be doubled in the next five years.

"By 1910 we shall probably see 900 or 1,000 miles of these old lines operated electrically, and as great a length in addition of new lines—tramways and light railways—built, perhaps at a slightly less cost than the old ones, but still averaging at least £6,000 per mile of route length. Very many of such new lines would consist of single track with passing places; a low average, at about the above rate, may therefore be taken. A thousand miles of double track at £10,000, and another thousand at £6,000, bring the total up to £16,000,000, which may be looked upon as the minimum amount of capital to be invested in electric tramway lines in Great Britain before 1910."

The exact conditions under which this work will be done cannot yet be altogether foreseen, but that it will be done by some one, and done under satisfactory conditions may be distinctly understood. It represents just that much new work developed where it did not before exist, and it will be done either by home labour, home engineers, and home capital, or it will go to the foreign competitors who have already gotten their foothold in this very line of construction.

A very important question in this connection is that of deciding what interests shall best carry on the work. Shall it be done by the municipality or by private management? If the municipality so chooses the public body can always have the preference, but those who have had much experience in this particular direction feel that the municipalizing tendency in regard to tramways may be carried too far. Indeed it is frequently stated that the retarding influence of municipal control is the immediate cause of the backwardness of Great Britain in electric traction. Apart from this much-discussed question there is no doubt that experience has shown that the most successful development of electric

tramways lies in the construction of connecting lines, and indeed in the United States, the communicating lines often run through and within several adjacent towns, a most valuable plan, easily carried out under private ownership, but difficult indeed under mixed municipal control.

There are doubtless two sides to this question, and while private enterprise has been most successful in other countries, a number of corporations have also done well, and with capable and independent men at the head of tramway committees there is no reason why good work should not be done by municipalities.

Be this as it may, there is no question that the work is coming and must be done by somebody, and whatever view may be taken in regard to the proper method of extending tramway facilities, there is not the least doubt that there will soon be remarkable developments in which both private and municipal enterprise will both play important parts.

Photographic Surveying.

VARIOUS papers upon the possibility of applying photography to surveying have appeared from time to time, the most practical being the work of Mr. Deville for instruction in actual work on the Canadian survey. We now have a general résumé of the whole subject in the form of a paper before the Society of Engineers by Mr. J. Bridges Lee, including an account of some improvements which he himself has made in the instruments, and a description of the method employed in the Canadian survey for plotting the maps from the photographs.

In producing a perspective drawing from plane projections the object is to produce from what may be termed maps, a picture of the subject as it appears to the eye. Photogrammetry, as it has been called, is the reverse operation, the production of the map from the perspective, and, as the paper shows, there is no difficulty in producing excellent work very rapidly by use of the camera, if proper precautions are taken in making the views from which the subsequent work is done.

After referring to the original objections to the use of the camera as a surveying instrument Mr. Lee shows how the introduction of gelatino-bromide dry plates and modern photographic lenses have enabled the real difficulties to be overcome, and the only remaining objections to the method for general work arise from the conservatism and inertia of professional workers, and an unwillingness to take up with the new method so long as the old ones will be accepted.

Apart from the rapidity of the method, the great advantage lies in the fact that when the photographs have been taken they contain all the data, so that omissions or the discovery of errors of measurement cannot occur to require revisiting the field. This is of especial importance in connection with the work of explorers and military engineers, who by the use of the surveyor's camera may secure photographs to be subsequently worked up by others.

The principal improvements which Mr. Lee has made in the instrument are: the introduction of horizontal and vertical hairs in contact with the plate, giving bases for measurement, and positive indication of the presence of distortion; the placing of a compass with transparent scale inside the camera in such a manner that the vertical hair serves as an index for reading the compass bearing; and the introduction of a scale, photographed by contact on every plate, enabling the exact focal length of the lens to be determined. He has also arranged hinged carriers so that data relating to any exposure may be written on transparent pieces of celluloid and inserted so that they will be printed directly upon the negative, thus avoiding any uncertainty as to the identity of a negative, or doubt as to the data which belong to it.

In connection with the field work, the same general rules apply in the selection of stations as obtain in plane-table work. The important thing is to remember that the topographer in the office cannot obtain good intersections from cross views which would not have yielded good intersections in the field. A moderate degree of experience in both photographing and plotting will soon teach the operator how to select his views, and the work will be found far more rapid than that with the plane table.

As already indicated, the plotting work is the exact reverse of the making of a perspective drawing. The points are iden-

tified in each photograph, transferred by strips of paper to the trace of the picture-plane, and to the distance line, and threads stretched from the station points to corresponding points on these lines give by intersection the positions of the points on the plane.

Judging from the success of the method on the Canadian survey the method will probably come into extensive use elsewhere.

The Crystalline Structure of Metals.

THE study of the physical constitution of metals and metallic alloys by the employment of the microscope in connection with etching processes continues to add much to the engineer's stock of information concerning the reasons for the behaviour of such material under various conditions, and one of the latest contributions to this branch of science is the Bakerian lecture of Professor J. A. Ewing before the Royal Society.

Most of the researches in metallography which have thus far been made relate to the physical constitution of the metal after it has been cast, wrought, or otherwise prepared for use, but this paper discusses the effect produced upon the structure by the application of stresses, and consequently undertakes to reveal the nature of what is called strain.

The result of the study of metallography has established the fact that a metal is a structure composed of irregularly-shaped grains, with clearly defined boundaries, and these grains have been shown to be crystals formed upon solidification. The nature and dimensions of these crystals depend upon the composition of the metal, upon the rapidity of solidification, and upon the subsequent treatment, but it is now believed that under no circumstances does any metal cease to be crystalline.

When, by polishing and etching, the crystalline character of any metal has been determined under the microscope, it is practicable to determine the extent to which this structure is modified by subsequent stresses. If the stress does not exceed the elastic limit, the structure does not appear to be materially affected, but if a greater stress is applied the effect becomes distinctly apparent. When in any way the stress exceeds the elastic limit, lines appear upon the surfaces of the crystalline grains, these lines generally being straight and parallel for each grain, but changing in direction from grain to grain. It is possible, by examining these lines, to determine the boundaries of the crystals even though the surface has not been previously etched, and as the stress continues to be applied the lines increase in number and distinctness, several systems appearing on each grain.

These lines indicate slips along the cleavage planes of the crystals, their appearance varying according to the character of the illumination, and, since observations indicate that they appear in all metals, they may be taken as evidence of the general crystalline nature of metallic substances. The fact that these slips occur along cleavage planes permits the metal to retain its crystalline structure during so-called "flow," the gliding taking place over the cleavage planes and the elementary pieces retaining their crystalline character. Sometimes the yielding is by simple slippage, the orientation being preserved unchanged, at other times it produces twinning, rotation occurring through an angle which is the same for each molecule of the twinned group, and both modes may be found occurring together.

A knowledge of the manner in which the crystalline particles of metals yield should go far to assist in the study of test specimens taken in actual practice, and, there is every probability that this branch of metallography will find useful practical application.

REVIEW OF THE CONTINENTAL PRESS

The Driving of Electric Generators.

EVER since the introduction of the dynamo-electric generator into commercial service the question of the best method of driving it has been a subject of discussion, and at the present time the subject of the power portion of an electric plant really constitutes the most important section of the work.

The question of the choice of motive power and the best methods of application form the subject of a paper by Herr Robert Friese, published in the *Zeitschrift des Vereines deutscher Ingenieure*, and presented before the recent convention of that society at Nürnberg.

After referring briefly to the electrical magnitudes of voltage and amperage as related to the mechanical elements of force and distance and showing how the equations giving the relations of electricity generated to power required may be derived, Herr Friese proceeds to consider the various methods of connecting the generator to the source of motive power by which it is driven. The development of the direct-connected generating set is discussed and the important influence which this development has exerted upon steam-engine design is shown to have been for the improvement of both generator and engine. With the earlier dynamos the high rotative speed required demanded quick-running engines, and although some very excellent machines of this type have been made, such as the Westinghouse engine in America and the Willans in England, yet it is generally conceded that the best economy is attained by larger engines operating at moderate rotative speeds. The improvements made in large alternating and polyphase generators render it possible to use such engines in direct connection with the generators, and this type, with vertical engines and large armatures built directly upon the engine shafts, is the prevailing form now used in large electrical stations where steam is the motive power.

The question of speed regulation has naturally been given much consideration in connection with the subject of driving electric generators, and Herr Friese has some interesting remarks to offer in that connection. While the centrifugal governor maintains its supremacy, in spite of its inherent defects, the demands of electric service have resulted in various improvements in the matter of speed regulation. The natural auxiliary of a governor is a fly wheel, and in one form or another the inertia of a revolving mass is generally relied on to assist in the maintenance of uniform speed. The usual method of expressing irregularity in speed is that of a percentage variation from the normal, it being stated that the speed shall not vary, for example, more than 2 per cent. above or below the standard, but this method does not give a clear idea of the conditions because it fails to take into account either the duration of the regulating operation or the number of variations from the normal which may occur during that time. The fluctuations of electric lamps, however, make both the extent and duration of speed variations visible. Herr Friese calls attention to the difference in sensitiveness of people in different walks of life to variations in brilliancy of electric lamps, and shows that fluctuations almost unbearable to persons of culture were hardly perceptible to the peasant laborer, so that the personal equation must be considered in this connection, as well as the service to which the light is to be put. As a matter of fact, the degree of variation in speed is not a constant factor, as some treatments consider it, but is a resultant of varying influences in every portion of the combined machines. All that can be expected is the restriction of the variations within certain predetermined limits, and this should be effected not only by regulating the impelling power after the variations have occurred, but by so combining the parts that the variations may neutralize each other as nearly as possible, and at as early a point as possible after their inception.

As an example of what can be done in this direction, the subject of the connection of electric generators in parallel is discussed, and the equalizing effect of two generators is illustrated by comparison with that of two engines geared in parallel with a certain degree of elasticity in the connections. The use of accumulator batteries for the purpose of equalizing variations in the load is also considered, and the analogy of such batteries to fly-wheels is clearly shown.

The probable use of gas engines for the driving of electric generators is considered, and although the single cylinder four-cycle engine is considered unfit for this service, Herr Friese maintains that with two or more cylinders, and with proper arrangements for the equalization of the load, there is no reason why the internal combustion motor, with its superior economy, may not come into general use as a motor for dynamo-electric machines.

Modern Sewer Construction in Paris.

THE extensive works which have been constructed near Paris for the purpose of conveying the sewage to the farms and disposal grounds below the city have been the cause of the development of some novel and valuable methods of construction, and from a paper by M. E. Fourrey in a recent issue of *La Revue Technique* some account of the methods of the various constructors may be taken.

The general character of the great undertaking by which the whole of the sewage of Paris has been diverted from the Seine and delivered over farm land to be utilised and purified before it gets into the river, was described in these columns more than a year ago, and it was then shown how the location of bends in the river rendered the construction of inverted siphons necessary. The siphons under the Seine have been constructed of riveted steel, but apart from these there are in the system a number of siphons traversing low lying ground and much large closed sewer work of importance. The construction of the great Clichy sewer, of which much has already been written, forms only a part of the system, and the portion of the work which is now of especial interest is that of the reinforced concrete conduits, of which a number of illustrations are given in M. Fourrey's paper. As a matter of fact, the extensive use which has been made of reinforced concrete in various parts of the extension of the Paris sewers has done much to attract attention to the general advantages of this mode of construction. A great part of the main aqueduct, together with the conduits for the distribution of the sewage over the irrigated area, has been made of reinforced concrete, with most satisfactory results as regards strength, tightness, and economy, the only objection to this work being that in case of change the old conduits cannot be taken up and relaid elsewhere as can be done with metal pipes.

The most interesting example of construction is that of the Chennevières siphon, which consists of a conduit 6.28 feet in diameter and 1¼ miles long. Since the maximum head is about 42 feet the pressure is about 18 to 20 pounds per square inch, which is readily sustained by the cement and imbedded metal. This conduit is formed in sections consisting of cylindrical metal cages, the circular members composed of T iron with longitudinal connections of channel bars, the whole being interlaced with an intermediate trellis of round rods. These sections were placed in position in the trench and a concrete of Portland cement filled in in such a manner as to enclose the metallic skeleton entirely, thus forming a smooth continuous tube having the tightness and durability of cement pipe together with the strength of the metal reinforcement, and the added advantage of the absence of joints.

Another example of the successful use of reinforced concrete is found in the large tunnel for the Argenteuil siphon. In this case the conduits themselves are of steel pipe, two such pipes being carried across the Seine on the handsome steel arch bridge recently constructed for the purpose, these pipes then passing through the tunnel. This latter is of elliptical section, 17 feet wide and 11 feet high, and is built of concrete applied to a skeleton of steel rods, erected in place and connected together so as to form a continuous reinforcement of the whole structure. The circumferential members of the skeleton are of round rods

⅝ inch in diameter, bent to the form of the elliptical vault and secured at the ends to channel bars imbedded in the concrete at the springing. These arch rods are interlaced with longitudinal rods 5-16 inch in diameter, forming a trellis with spaces about 4 inches square, and as the metal work was erected it was filled in with cement to a thickness of about 3 inches, the whole hardening into a solid mass of great strength and tightness.

The successful use of reinforced concrete in such important structures should be followed by similar applications in other parts of the world, especially where cheapness, strength, and rapidity of erection are to be considered.

It is interesting to note that the works were completed in July of the present year, so that now all Paris wastes go into the sewer and none into the Seine.

The Strength of Rubber Hose.

THE introduction of steam heating in railway carriages has made it necessary to provide rubber hose connections which shall stand the rather severe duty of this peculiar service. In the case of air-brake hose the problem is confined to securing tightness against leakage of air under pressure, and endurance of the wear and tear of operation and handling. For steam heating connections, however, there are effects of steam and the action of hot water to be considered, and experience has shown the necessity of providing strict specifications and exhaustive tests, in order to insure satisfactory results.

A series of tests has recently been made at the Government Testing Laboratory at Charlottenburg, and the results are now made public in a paper in the *Mittheilungen* by Professor Rudeloff, and as the subject is one of international interest an abstract of his paper is here given.

The requirements of the German government for steam hose are very strict, and are in substance as follows:

The hose is to be made with five layers of pure linen with sheet rubber between, and is to be covered without with linen. It must stand an internal pressure of 150 pounds per square inch, either hot or cold, without injury, and when subjected to internal pressure of 60 pounds for four hours should not twist. The rubber must be free from foreign substances. A temperature of 350° F. sustained for four hours should not affect the strength nor injure the hose in any way. The presence of hot water under pressure should not cause the linen to be easily separated from the rubber nor the layers of rubber from each other.

Holding these requirements in mind, the tests made by Professor Rudeloff may be considered in brief.

After a careful measurement and inspection of the samples they were subjected to an internal pressure of 150 pounds with water at the temperature of the air, with water at 170° F., and with steam pressure. A pressure of 60 pounds was then maintained for three hours, and an inspection for defects then made, after which the sample was subjected to a heat of 350° F., both with steam and with dry heat, and the strength of the material then examined. The adhesion of the linen to the rubber was also determined, both for the original condition and after exposure to the action of boiling water.

The specimens tested were about 22 inches in length, 1⅜ inch internal diameter with walls ⅜ inch thick, and examination showed that the rubber penetrated the fibres of the linen so that it appeared to be of one entire mass. A number of samples were tested, and the results are tabulated fully in the original paper, together with a description of the apparatus used. The circumference of each piece was carefully measured near each end and in the middle, both before testing and afterwards, as well as during the application of the pressure, and similar measurements were made of the length.

So far as resistance to cold water pressure is concerned, the specimens tested gave excellent results, the slight increase in diameter under 150 pounds pressure disappearing entirely when the pressure was relieved. The corresponding tests with water at 170° F., resulted in a permanent increase in circumference of about ¼ inch, but the hose appeared otherwise unaffected. The specimens, however, failed to resist satisfactorily the test of 150 pounds steam pressure, as the circumference was enlarged nearly an inch and the length diminished 0.6 inch, while the outer cover-

ing was loosened and partly destroyed. The twisting action which takes place consequent upon prolonged internal steam pressure was shown by the fact that one specimen twisted 15 degrees when under steam pressure of 60 pounds for three hours, with a permanent twist of 8 degrees, and another specimen showed 9 degrees twist and a permanent set of 2 degrees.

The action of prolonged heat varied according to the manner of application. Rings cut from various portions and opened out, were pulled in the Rudeloff testing machine, both in the original condition and after heating. Exposure to steam heat at 350° F. for four hours made the rubber much softer, the extensibility under given load being increased fully three times and the ultimate strength diminished to less than one-fifth its original amount. Exposure to dry air at 350° F. for four hours, on the contrary, made the rubber harder and diminished the extensibility very greatly, although the ultimate strength was reduced nearly as much as with the steam.

When the material was exposed to the action of boiling water for half an hour the adhesion of the linen layers to the rubber was not appreciably reduced.

In view of the importance of producing hose which shall satisfactorily meet the requirements of the German railways these tests should prove of especial value not only to manufacturers of rubber goods, but also to the engineering profession generally.

Electric Driving in Rolling Mills.

In applying electric power to the driving of machine tools it was at first assumed that such motors could only be advantageously used for moderate powers and where the load was comparatively uniform. With increased experience, however, the adaptability of electric driving has been extended to larger capacities and to a great variety of work, and in a paper by Herr O. Lasche, in a recent issue of *Stahl und Eisen* an interesting account is given of the successful installation of electric motors for the driving of the rolls for copper wire and rod in the establishment of the Allgemeine Elektricitäts-Gesellschaft at Berlin.

The driving of rolling mill machinery has always rightly been considered a severe test of the regulation of any motor, and builders of steam engines have made especial efforts to improve the governors of direct-connected engines for this work in order to control the speed successfully under the sudden changes from full to no load, as the rolls must be operated. The experience of the above company, however, shows that the difficulties have been successfully overcome in this case, and doubtless this experience will lead to a wider extension of the use of the electric motor for this line of work.

The machinery of this plant consists of four sets of heavy rolls and seven of fine rolls, these being used to reduce copper bars of 60 kilogrammes weight and 0.8 square decimetres section to wire of 7 millimetres diameter, the output per day of 11 hours being about 200 kilometres of wire, the day's work requiring about 27,000 kilogrammes of copper. The heavy rolls are driven by a polyphase motor of 200 h. p. making 380 revolutions per minute, connected by rope gearing through sheaves of 1.4 metres and 5 metres respectively with the main roll shaft. The fine rolls are driven directly by a polyphase motor of 400 h. p. making 420 revolutions and directly connected, a fly-wheel being attached to the motor.

Without going into details of the work performed by this machinery in this particular installation it may be of interest to examine the investigation which Herr Lasche gives of the behaviour of the polyphase motor under sudden fluctuations of load, together with the influence of the fly wheel as an equalizer.

The action of the armature of the motor may be compared to that of a pulley driven by a belt. When there is little or no load the perimeter of the pulley travels at practically the same lineal speed as does the belt by which it is driven. When, however, the load is thrown on there is more or less slip. In the case of the electric motor the rotary field corresponds to the belt, and the loss in speed of the armature when the load is thrown on resembles the slipping which takes place in the case of the pulley.

When a motor is used under sudden fluctuations of load, as is the case in driving rolls, the action, in connection with that of a fly wheel, may be divided into two

phases, the period of work and the period of recovery. As in the case of a steam engine or other motor the fly wheel, by its inertia, acts as a reservoir of energy, at first assisting the motor to tide over the sudden demand, and then in turn preventing the sudden release of load by demanding a return from the motor of the energy which it advanced a moment before. By plotting these relative actions in the form of curves, the fluctuating load of the rolling mill may be combined with the absorbing and recovering action of the fly wheel, and the equalizing effect upon the load which reaches the armature of the motor is well seen. Several such diagrams are given by Herr Lasche for fly wheels of different masses, and the influence of a change in the weight of the wheel is thus seen.

In the case of the heavy rolls in the mills above described, the diagrams show that the speed of the main roll-shaft falls only from 105 to 103 revolutions when the load increases from 80 to 220 h. p. in the short space of 20 seconds. Similar good regulation appears in the case of the fine rolls, the speed of the motor falling from 420 revolutions to 410 in the 12 seconds in which the load jumped from 80 to 360 h. p.

The entrance of the electric motor into this difficult field of service is one more demonstration of the applicability of this form of driving not only to heavy machinery, but also to machines operating under the most trying of work-shop conditions.

The Turbines at Rheinfelden.

THE great hydraulic power plant at Rheinfelden has been described in various publications, as its importance demands, and these accounts were naturally of the general character which the broad interest in the work has awakened. We now have a special description of the turbine wheels themselves in an interesting paper by Professor Franz Prásil, in the *Schweizerische Bauzeitung*, and in view of the special problems of the case the paper demands notice.

The difficulties encountered at Niagara were mainly those due to the great head of water and the transmission of large units of power from the depths of the wheel pit, the head of water being practically invariable. At Rheinfelden, on the contrary the mean head of water is only about 12 feet, with a variation of more than 3½ feet between high and low water, so that turbines of large diameter were required, and the question of close regulation demanded especial attention.

The requirements of the engineers were that each unit should have a minimum power of 840 h. p. at 55 revolutions per minute with the lowest head of 10½ feet, and that there should not be an appreciable difference in efficiency between the performance at this head and at a head of 13 feet. To meet these conditions it was decided that each unit should consist of two wheels upon a single shaft, each wheel being made in four sections, of 7.6 feet in diameter, the sections being made of such depths as to permit the development of 840 h. p. for the various changes of head under which they might work. By the use of annular sleeves, controlled by the governing mechanism, the flow of water can be cut off from the several sections successively and thus the power regulated without the loss of efficiency consequent upon the operation of a large single turbine at part gate.

In general design the turbines are upon the Francis inward-flow principle, and as it was very necessary to avoid disturbing interference of currents in the discharge water there were three outlets provided for each unit. The water enters through the guide vanes and, passing through the buckets of the revolving wheels is delivered, half upward and half downward from each wheel, so that there is required one discharge channel between the two wheels, one above the upper wheel, and one below the lower wheel, these three uniting into a single large delivery passage or tail-race. The middle and lower passages are formed in concrete, reinforced with imbedded steel beams, while that from the upper sections of the upper wheel is of sheet-iron. Both wheels are mounted on a vertical shaft 11.8 inches in diameter and about 50 feet long, this shaft carrying on its upper part the rotating portion of the electric generator.

The regulation is effected by means of a centrifugal governor which controls the movement of the annular gates encircling the guide vanes of each ring, or section,

of the wheels. These sleeves are connected by rods to the pistons of differential motors, the valves of which are controlled by the governor. With this apparatus the speed regulation is effected within a variation of about 6 per cent., notwithstanding the fact that the head of water varies nearly 30 per cent. from the mean, in addition to the varying demands for current upon the electric generators.

It was originally intended to install 20 of the units, each of 840 h. p., operating at 55 revolutions per minute, but after a portion of these had been erected it was decided to increase the speed to 68 revolutions, this being found more suitable for the electric generators. This change was accomplished by a change in the proportions of the remaining wheels, and in Professor Prásil's paper the dimensions of both types are given for comparison. There are now in use 9 turbines running at 55 revolutions, and 11 at 68 revolutions, and the whole set, constructed by Messrs. Escher, Wyss & Co., of Zurich, is operating in a very satisfactory manner.

Seasoning Wood by Electricity.

THE importance of thoroughly seasoning timber before it can be satisfactorily used in the arts is well known, and many varieties of kilns and drying devices have been constructed to facilitate the operation of preparing the green wood for conversion. The principal difficulty about existing processes is the length of time required for even a superficial seasoning, and even with great care it is difficult to ensure the thorough drying of the inner portion of heavy timbers.

A new process has recently been devised in France by MM. Nodon and Bretonneau, in which the action of an electrical current to produce osmose is utilised, and from an account in *L'Electricien* the following account is abstracted.

The material which we call wood consists essentially of two portions, one consisting of the cellulose or fibre together with the lignose, or binding material, while the other portion is the sap, or liquid. The sap is composed of water containing albuminoids and nitrogenous matter, and while in the living tree its presence is as essential as is the blood to a mammal, yet it contains the elements which produce rapid decay in the felled timber. The process of seasoning, therefore, is really nothing more than the removal of sap, and upon the completeness with which this removal is effected depends the durability of the resulting timber.

Ordinary drying, even if completely effected, only partially accomplishes the desired object, since much of the putrescible matter is only held in suspension in the water of the sap and remains in the pores of the wood ready to start and propagate decay. Even this incomplete seasoning, however, is most difficult to accomplish entirely, and it is well-known that long periods of time are required to produce a satisfactory result. The pine which is used for the sounding boards of pianos, for instance, is sometimes kept for many years before it is found suitable for use, and it is difficult to insure complete drying under any circumstances.

It is well known that an electric current in traversing a porous substance will carry with it the particles of a liquid in which the porous body is immersed, and it is this property which has been utilised in the new process. After making many attempts to drive out the sap by pressure, suction, soaking, etc., MM. Nodon and Bretonneau tried the effect of an electric current. The experimental process was as follows:

A stick of green wood was placed in a vat, a piece of sheet lead beneath the wood forming an electrode, and the vat being filled with water, leaving the upper part of the wood above the surface. Upon the upper surface of the wood was then placed a vessel having a porous bottom and filled with water, into which was plunged the other electrode. After the passage of the current for several hours it was found that the pores of the wood were entirely filled with water, while the sap was transferred to the body of water in the vat. The wood then being removed and exposed to the air, rapidly became thoroughly dry, the water evaporating much more freely from the pores than could the gummy sap, and when dry the wood was found entirely free from any matter liable to promote decay.

It is evident that some liquid other than water might be used in the porous vessel placed above the timber, and the whole

mass of the wood might thus be fully charged with an antiseptic preservative if so desired.

The electrical resistance naturally varies according to the nature of the wood, as well as to the thickness and humidity of the specimen; on an average the passage of a current corresponding to 6 electric h. p. is sufficient for a cubic metre of wood. The usual time required for treatment is 3 to 4 hours, with a current of 10 to 15 amperes.

A careful examination of the effects of the passage of an electric current through a timber in the above manner reveals the following results:

A portion of the salts which may be contained in the solution penetrate by electro-capillarity into the pores of the wood.

An osmotic exchange occurs between the constituents of the sap and the solution employed, this exchange being effected throughout the entire mass of wood traversed by the current. At the same time an electrolytic action occurs which converts a portion of the salts contained in the sap into inorganic compounds, not liable to decomposition. This electrolytic action appears to destroy the living character of the sap without requiring it to pass through the intermediate decomposing stages. It is also maintained that the action of the current tends rather to toughen the fibre of the wood itself and improve it rather than act injuriously.

The extent to which these claims will be confirmed by actual experience can only be determined after the lapse of time, but the principle appears to be sound and the method is so fully described as to enable experiments readily to be made.

Automobiles in France.

THE early development of the modern automobile vehicle in France has naturally led other countries to look thither for the results of experience. This is the more natural because there has been much competition, besides various trials, exhibitions, and reports, while the freedom which has been permitted in the use of all kinds of motor vehicles renders the information thus obtained of a most practical nature.

The general reports of the competitions of 1898 and 1899 have appeared in various publications, and have been reviewed from time to time in these columns, but now we have a critical discussion of the engineering side of the information obtained from these trials in the form of a paper presented before the *Société des Ingénieurs Civils de France* by M. G. Forestier, the well-known inspector general of the *Ponts et Chaussées*.

So far as automobilism as a sport or recreation is concerned, M. Forestier regards the question as entirely settled, and hence devotes himself entirely to the practical side of the problem of commercial mechanical traction on public highways.

The trials of 1898 were of heavy road vehicles, and for this service the only motive power attempted was either steam or gasoline.

The steam vehicles were fired with coke, with heavy oil, and with gasoline, while in a number of instances internal combustion motors were used, the gasoline acting directly in the cylinders.

For tabulated details of the tests reference must be made to the paper of M. Forestier, but the general conclusions are that steam power is the best where sudden demands for power are made such as steep grades or starts on ascending inclines, while an internal combustion motor is satisfactory for fairly level roads and is much lighter in weight. Both classes of motors showed a notable advance in economy over similar vehicles tested in 1897, and there is prospect of further improvement in this respect.

Deducting the weight of the vehicles, the cost of hauling merchandise on common roads by steam motor vehicles is given as 0.373 franc, 0.200 franc, and 0.140 franc, per ton-kilometre, according as they are operated with 1-3, 2-3, or full load, while for the internal combustion motor the corresponding costs per ton-kilometre are 0.673 franc, 0.369 franc, and 0.268 franc.

Since the average cost of animal traction under similar conditions is about 0.25 to 0.30 franc, it is evident that mechanical hauling of merchandise can only compete successfully with horses when full loads are carried. When unbroken loads of 9 to 10 tons are to be transported at speeds above 4 kilometres per hour the motor vehicle is the only one which can be used, and it is believed that the improved merchandise trucks will prove capable of speeds up to 6 kilometres with heavy loads as a conse-

quence of the experience gained from these trials.

The details of the trials of the light vehicles are too voluminous to be discussed at the present time, but the following tabulation of costs per day for the operation of cabs and delivery wagons will be of interest.

	Cost per Day.		
	Horse.	Gasoline.	Electricity.
Cab	19.26f.	16.27f.	18.48f.
Delivery Wagon .	16.72f.	12.80f.	14.80f.

The figures include interest, depreciation, and in the case of the electric vehicles, maintenance of accumulators.

The Microscope in Engineering Work.

THE Royal Testing Laboratory at Charlottenburg is constantly doing good work in connection with the properties of the various materials of construction used in engineering, and its transactions, which appear at irregular intervals throughout the year, contain much that is of value in practical work.

In a recent issue of the *Mittheilungen* of the institution the subject of the use of the microscope in connection with the study of the physical constitution of metals is discussed, and the views of the Director, Professor Martens, and also of Professor Heyn, are given in a excellent illustrated paper.

Although the microscope has long been considered of value in certain lines of engineering work, it is only in the hands of trained observers that direct results of value can be obtained, but when the microscope is used in connection with the camera, permanent records may be secured which have a lasting value for purposes of study and comparison, which is only beginning to be appreciated.

The best results in this line of work can only be obtained by the use of special apparatus and the micro-photographic camera devised for use at Charlottenburg, by Zeiss, of Jena, is illustrated and described as a satisfactory model for study and imitation. This apparatus is arranged for use in either the vertical or horizontal position, and includes many auxiliary devices for use in handling and illumination which have been developed in the course of experience at Charlottenburg.

The most extensive use which has been made of photo-micrography has been in connection with the study of metallography, or the physical character of metals as revealed by the action of etching solutions upon polished surfaces, but in many instances very instructive results have been obtained by polishing sections of the metal and photographing the enlarged image without etching in connection with such oblique illumination as will best bring out the unequal abrasive action upon the constituents of varying hardness.

The paper gives a tabulated account of examinations of a number of specimens, with photo-lithographic reproductions of the results, showing very clearly the extent to which this method may be used to reveal the character of the metal under consideration. In some cases the same subject was photographed both in the ordinary manner, and with an orthochromatic plate, the advantages of the latter being evident in certain instances. The most satisfactory source of illumination was found to be the oxy-hydrogen light, using illuminating gas in place of pure hydrogen and a pencil of magnesia instead of a lime cylinder.

Among the illustrations may be mentioned drawings of the conveniently arranged dark-room used at the laboratory, while the paper contains much valuable information about the special objectives found most valuable for the work.

Taken in connection with what has already been published upon the science of metallography, this paper upon the practical side of the work will be welcomed by engineers elsewhere who are engaged in the study of materials of construction.

REVIEW OF THE AMERICAN PRESS

Steam Engineering in the United States Navy.

IN view of the remarkable work which has been done by the various vessels of the United States Navy during the past two years, the report of the Engineer-in-Chief, Rear-Admiral George W. Melville, is a paper worthy of especial mention at this time.

The year which is covered by the report has been one in which it was expected that many important lessons would be learned, since the cessation of hostilities made it possible to proceed with the repairs and reconstruction work which active service had made necessary. It is a most reassuring evidence of the excellent character of the work on the various vessels to learn that no desirable change in the machinery has been found advisable, with the exception of an increased capacity of the evaporating plants, and the adoption with all practical and economical promptness, of the water-tube type of boilers. The importance of providing ample capacity in the evaporating plants follows of necessity the adoption of water-tube boilers, since the damage resulting from the use of salt water in such boilers was fully demonstrated in the case of the boilers of the torpedo boats.

So far as the water-tube boilers themselves are concerned, the eminently wise policy has been adopted of progressing with such proper speed as is necessary to avoid mistakes and to obviate sacrifice of still useful boilers of the older type. The boilers under immediate consideration are the Babcock and Wilcox, several installations having been made of this type on existing vessels of which the Scotch boilers were worn out, and the Niclausse and Thorneycroft boilers for the battleships now building.

It is interesting to note that the present status of the water-tube boiler is regarded by the Bureau of Steam Engineering as depending more upon protection from deterioration when not in use than upon efficient output during actual service. There seems to be no question as to the value of the water-tube boiler as a rapid and efficient generator of high-pressure steam, nor of its ability to stand hard forcing in time of emergency. The real question lies in the preservation of the boilers during the years of ordinary naval service which do not call for more than a very limited use of the entire plant. This feature has often been ignored by designers of water-tube boilers, and yet it forms one of the most important differences between land and naval service, and evidently demands careful study and consideration.

An interesting feature of the report is that portion which discusses the character of auxiliary machinery. The agitation which has been made in some quarters for the installation of electrical power-plants on shipboard from which all auxiliaries shall be operated by means of electrical motors, while doubtless having some good arguments for its support, has not found favor with the Bureau, and the conclusions of Mr. Melville in this matter appear to be eminently sound. When the difference in conditions on shipboard and ashore are considered it will be seen that the high economy attained in the machine shop by the use of electric driving can hardly be expected under the varying service on vessels. The improvement in the economy of steam auxiliaries has been such that excellent results are now obtained, so far as efficiency is concerned, and when, as is now commonly the case, the exhaust steam from the auxiliaries is either used to heat the feed water, or is discharged into the receivers of the main engines, the economy of the whole plant is found to be excellent. That the Bureau has no prejudice against electric driving in itself is plainly shown by the fact that it has been adopted altogether for the new shops at the New York Navy Yard now being constructed to replace those recently destroyed by fire.

Another line of work of the Bureau which is of interest to mechanical engineers

is that of the drafting room, including the general preliminary work which must be continually made in order that the machinery of the vessels of the navy may be kept up to the constantly advancing standard of current international practice. Among the most important matters under consideration in this department may be mentioned the questions of best cylinder ratios for multiple-expansion engines, economical arrangements for using superheated steam, practical limit for true economy in forced draft, reduction of cost of horse power of auxiliary machinery by improved design, efficient heating of feed water by exhaust steam, and the still further improvement of the screw propeller.

In connection with the work of inspecting the materials and workmanship upon the vessels now under construction, it is gratifying to find that there has been great improvement in the manufacture of high-grade forgings, and the severe requirements for forgings of nickel-steel, either oil-tempered or annealed, have been very successfully met.

The practice of the Bureau of supervising with competent officers such tests and experiments as may prove of value to the department, has been continued, and among the tests upon which reports have been made may be mentioned trials of Babcock and Wilcox and Niclausse boilers, also tests of main and auxiliary machinery on the lake steamers Alexander McDougall and Pennsylvania, as well as of mechanical stokers on the latter vessel, while experiments on liquid fuel are still in progress.

The whole tenor of the report is to emphasize the essentially mechanical work of the Bureau, and demonstrate the mechanical character of nearly all the work on board a modern war ship. The manner in which the Chief refers to the mechanical nature of electrical engineering is of especial interest in this connection.

"The operation of electrical machinery is purely mechanical. That this may be done efficiently requires good mechanical ability at the generating engines. Electrical difficulties and casualties are almost always questions of mechanical engineering. I know that it conduces to the efficiency of the service, to the feasibility of a more extended use of electricity, and to an increase in the life of the electrical apparatus if the electrical plant were placed in charge of this Bureau. I desire to call attention to the fact that it is almost the universal commercial practice to place electric generating plants in the charge of mechanical engineers."

Piece-Work.

THE question of the best method of remunerating labor is receiving much attention at the present time, and it has become evident that in the midst of the changing methods of works-management the ancient method of measuring the value of a piece of work by the time expended in making it will have to give way to some more rational system, and that it must be practicable to arrange matters so that both employer and employee shall be benefited by the change.

An excellent discussion of one phase of this matter is found in a paper presented before the Western Railway Club by Mr. R. T. Shea, treating of the methods of piece-work in a railroad shop, and while the discussion relates primarily to railway practice in America, yet it is so broadly treated as to be of general interest and value.

Works managers are beginning to realize that the important matter is the actual money-cost of the finished product, not the absolute amount of wages earned by the workman. Low wages are by no means the cheapest, nor is the pay roll the only item of cost. The cheapest man is not the one who gets the least pay, but the one who makes the cheapest articles. The fixed charges of an establishment, usually amounting to as much as the pay roll, must be paid on a time basis, and hence the less the time expended on a piece of work the smaller the portion of the general expense-charge it must bear, and so the advantage of rapid production of an article is by no means limited to the saving of the workman's time. It must not be forgotten that the final transaction, *i. e.*, the sale of the article by the manufacturer to the customer, is always on a piece basis, the customer caring nothing for the amount of time spent on the article, but tendering only a fixed piece-price for it.

The method of paying workmen by the day is really a survival from ancient times,

probably originating in pastoral and agricultural countries, where the value of the labor of all the men engaged in such simple occupations was practically uniform, and in which time was doubtless a fair measure of it. When the skilled mechanic appeared, he was at first an individual workman doing all by himself, and dealing directly with his customer, and so necessarily earned his pay on a piece basis, being practically in business for himself. When, still later, the employer of mechanics appeared, he used the only process of paying for labor known to anyone, *i. e.*, the day wages, notwithstanding the contradictory relation which appeared between time for production and selling price of product, and ever since that time the attempt to reconcile the contradiction has been continued.

The introduction of the piece work system is practically a return to the idea that every mechanic should be in a sense in business for himself, the only real reason for his association with other workmen under one employer being the necessity for centralization in order to secure the advantages of power-operated machinery. Under the piece-work system the employer no longer holds the old relation of master over a body of servants, he is rather a jobbing customer of a number of mechanics in business for themselves.

The great defect in this apparently ideal method lies in the fact that this wholesale employer-customer too often takes advantage of his position to attempt to force prices down below the stimulating rate until they reach the discouraging point. The true advantage of piece-work is that it encourages the workman to do his best, its weak point lies in the fact that it is too often abused into discouraging him in the struggle.

Many employers cannot get rid of the old day's-work fetich after they have introduced the piece-work system, and persist in comparing the earnings of the men under piece-work with what was formerly considered the "going-rate" by the day. Instead of watching to see that the workman does not make very much more by piece-work than he formerly did by day-rate, the manager ought to devote his attention to the cost of the product, as compared with its former cost. The only conception of reducing cost under the old system was the lowering of wages, and the old-time manager cannot bear to see the workmen earning 40, 50, or 60 per cent. more than formerly, and so, without regard to the fact that his product is costing him far less than formerly, he thinks to himself that "these men are making too much," and the rate is forthwith cut. The result is either protest, resistance, or discouragement on the part of the men, and the system gets the blame due only to its abuse.

Mr. Shea gives many instances of the excellent working of the piece-work system in railway shops, showing how entirely satisfactory it may be made, both to employers and men, and in summing up he concludes:

"From both the manager's and engineer's point of view it is of value at the start, naturally progressive (a building-up process) and of almost unlimited possibilities in lowering the cost of production, increasing the organization, and rendering automatic the operation of a manufacturing works. Where it has failed it has failed because it has been totally misunderstood or misapplied.

Coaling Vessels at Sea.

AMONG the papers presented at the recent convention of the Society of Naval Architects and Marine Engineers was one of much interest by Mr. Spencer Miller, relating to the subject of coaling vessels at sea from colliers, without delay to the former or risk to the latter.

The importance of this subject was emphasized during the Spanish-American war by the difficulties encountered in laying colliers alongside, even in the quietest weather, and more than once serious disadvantages of position had to be temporarily permitted in order to enable coaling stations to be visited.

Mr. Miller calls attention to various propositions which have been made from time to time to transfer the coal over a cableway extending from the collier to the war ship, and shows that the great difficulty involved in the operation of a cableway as ordinarily constructed lies in the varying tension which must occur. It is necessary that one of the vessels be towed by the

other, and for considerations of safety to the weaker vessel the distance between the two should not be less than about 200 feet. The cableway, however, must maintain its proper position above the water if the load is to be transferred safely, and this means that any slack occurring by reason of pitching or tossing must be instantaneously taken up, while any excess of tension must be as promptly relieved, otherwise the load may be dumped into the sea or the cable subjected to a stress sufficient to cause it to part.

Various attempts have been made to regulate the tension upon the cableway by means of counterweighting devices, and a coal transporter with such a device was made according to the plans of Hon. Philip B. Low, and tested by the U. S. Navy Department in 1893. It worked well enough in perfectly smooth weather to demonstrate that the conveying apparatus offered no great difficulties, but the counterweight device proved inadequate in rough water, and the trials were not continued. Attempts have also been made in the French navy to coal at sea from a collier provided with a Tremperley transporter, but though these were at first partially successful they were terminated by damage done to the collier. Still the great durability of providing some means of coaling when at sea has led the French Admiralty to attach such a collier permanently to the Mediterranean reserve squadron.

The plans suggested by Mr. Miller involve the use of a cableway extending from the war ship to the towed collier, but provide in a novel manner for promptly taking up slack or relieving tension. The first plan was to provide the collier with a sea anchor attached to a moveable sheave in the bight of the endless cable, the war ship thus towing the sea anchor, the collier merely supporting the strands as they passed over. Trials of this system were made on one-fourth scale by using a tug boat towing a sloop in New York harbor, and although the weather was quite rough the correctness of the principle was fairly well demonstrated. A modified arrangement has now been placed on the U .S. collier Marcellus, and sea trials are expected to show the capabilities of the apparatus.

In the later form the collier is provided with a specially contrived winding engine, having two drums, both acting to wind in the two ends of the cable, the bight of which passes about a sheave on shear poles on the towing war ship. The two drums are provided with tension devices, the one maintaining a constant tension of 3,000 pounds, the other with a tension which may be varied between 1,000 and 4,000 pounds. The cable will always travel towards the drum of greatest tension, and hence by varying the tension on the one drum the carrier may be caused to travel to and fro as may be desired, while at the same time both drums take up very rapidly any slack which may be caused by pitching of the vessels. It is evident that the tension on the cable can under no circumstances exceed the frictional slipping resistance of the drum, and thus the working conditions appear to be well met.

If practical experience with this apparatus fulfills reasonable expectations one of the most difficult problems which has appeared in connection with the engineering side of the development of sea power will have been solved, and a freedom in naval tactics permitted to a extent hitherto not possible.

The Fuel Economy of Railroad Engines.

It is beginning to be recognized that the service required of power-house engines for tramways is of such a special character as to render it necessary to consider them in a class by themselves, and for this reason the paper presented by Professor R. C. Carpenter to the New York Street Railway Association is of much value at the present time. The paper consists of a discussion of the fuel economy of various kinds of steam engines, based upon tests made upon thirty-five different plants, and the results are so classified as to show the fuel consumption of several classes when operating under the usual conditions of power-house work.

The principal feature of power-house work for tramways is the very variable character of load, making it necessary to provide an engine capable of meeting the maximum demand which may come, and therefore operating under an average load much below that of greatest economy. The direct effect of this average underloading

is to reduce the economy of the engine from 20 to 40 per cent. of that obtainable when working under the most advantageous uniform load.

The tests included non-condensing slide valve and Corliss engines, and also compound engines, condensing and non-condensing, of the single and the four valve automatic types, and the results are tabulated both with respect to the steam and coal consumption. From these tables much interesting information may be obtained, not only with respect to the relative economy of the different types of engines, but also with regard to the broad question of the cost of a steam horse-power.

Taking the steam consumption per horse-power-hour as the fairest basis of comparison we have the following general results. For the plain slide-valve engine, non-condensing, the steam consumption averaged 34.3 pounds, and this was reduced to 22.7 pounds for the compound condensing engine. The consumption for the simple Corliss engine averaged 28.3 pounds, or 18.2 pounds when operated compound-condensing. These figures when compared with the performances of similar engines operating under the most favorable conditions show that the irregular loading of power-house work causes the economy to be affected adversely by 30 to 40 per cent. for the slide-valve engines, and about 20 per cent. for engines of the Corliss type. The best result obtained with a compound condensing Corliss engine was a consumption of 14.5 pounds of steam per horse-power-hour, and this was with an engine of 2,000 horse-power.

The question of original first cost of plant is also considered, and for purposes of comparison the figures are given for a plant of 500 h. p. This comparison reveals the fact, which has not been sufficiently emphasized heretofore, that the diminished boiler capacity required by the more economical engine nearly makes up for the increased cost of the engine, the simple non-condensing Corliss engine plant being given at $15,100 while the compound condensing Corliss plant is put at $16,625. The cost of a steam horse-power per year, including fuel and interest, but not including labor and oil, and taking coal at $2.00 per ton, and the day at 18 hours, ranges from $32.71 down to $14.46, the average for the compound condensing Corliss engine being $18.12.

In summing up, Professor Carpenter says: "These figures show that no station can afford to purchase and operate the simple non-condensing engine of any type as compared with the compound-condensing engine. The compound-condensing engine of the best type and with improved valve gear, although costing somewhat more, is so much more economical to operate, that, taking all things into consideration, it gives much better financial returns than an engine of any other class. These financial returns are so much in their favor that unless other conditions are exceedingly unfavorable these latter engines are the only ones which should be considered in purchasing machinery for power-house work. This general conclusion, that the compound-condensing engine of slow rotative speed and with improved valve gear is much more economical than any other type for power-house work, even when fixed charges are considered, is certainly the only one which can be adopted from the results of the tests."

Erecting Appliances for Shipyards.

THE extending use of mechanical appliances for handling as much as possible of the work formerly performed by human effort, is not confined to the machine shop and factory, but is to be observed also in the more modern shipyards, and the best present practice includes the use of portable tools, operated by power and supported by cranes, or similar appliances wherever possible.

Some of more extensive plans for use in shipbuilding are described in a paper presented before the Society of Naval Architects and Marine Engineers by Mr. James Dickie, and a brief notice will be of interest. Previous to 1884 the derrick-pole with swinging gaff was the only means in general use, but this has since been followed, by various forms of cantilevers, gantries, etc.

A good example of the cantilever is seen in the yards at Newport News, but this has its limitations. It only performs one of the four functions, of hoisting, carrying operative tools, erecting staging, and keep-

ing upper works fair, and as there is only one crane to two ships it is difficult to see how it can do all the hoisting for one vessel since the time of hoisting and travelling is such a small part of the work. The average hoist takes about forty seconds, traveling to destination about 55 seconds, while it takes from seven to twelve minutes to get sufficient bolts in a shell-plate or beam to enable the crane to be let go.

On the lakes the overhead gantry is used, traveling on rails on the ground on each side and covering the whole of the vessel. Two cranes are used for one vessel, and as the vessels are built broadside to the water the cranes are simply run to each end at the time of the launch; but these can only do the hoisting.

At the yards of Harland & Wolff, at Belfast, the large gantry, about which much has already been written, was constructed for use in the building of the Oceanic. This machine performs both the functions of hoisting and riveting, but its operation appears to be limited by the fact that it cannot cover more than 120 to 150 feet in length of the vessel at one time, and its size and weight must render it slow in operation.

The plan advocated by the writer is that of a framework covering the entire vessel while building. This is in use at the yards of Messrs. Swan & Hunter, on the Tyne, and at the Union Iron Works, at San Francisco, and is the most complete arrangement of all, as it enables all four functions to be fully performed. Overhead traveling cranes cover the entire area of the vessel, while jib cranes on both sides beneath these are used for carrying riveting machines and other tools. A 50-foot jib crane at each end enables work to be done on a vessel 100 feet longer than the framework structure, and operations can be carried on on all parts of the vessel at the same time.

At the Union Iron Works there are four of these structures, three of them being 300 feet long, and one 408 feet; the latter being large enough for a vessel 500 feet in length, by reason of the jib cranes at the ends.

The greatly increased advantage which such complete methods of handling materials and introducing portable mechanical tools, such as hydraulic and percussion riveters, drills, caulking tools, etc., gives to the establishments so equipped, must compel others to devise similar methods of work, and a marked reduction both in time and cost should be the general result.

The Purification of Water by Ozone.

SEVERAL months ago there was noticed in these columns the process of MM. Marmier and Abraham for the sterilization of drinking water by the use of ozone, with especial reference to the installation at use in the city of Lille, in France, the success of the process, so far as sterilization was concerned, seeming to be very effectively accomplished. We now have a paper upon the same subject by Mr. George A. Soper, prepared at Columbia University, New York, and published in *Engineering News,* not only reviewing the various French experiments, but also discussing his own investigations.

After briefly noticing the nature and methods of production of ozone in the laboratory, and showing that its value lies in its powerful oxidizing action, Mr. Soper goes on to describe the work of Tindal at Amsterdam, upon water taken from the Old Rhine at Oudshoorn, and upon Seine water at Paris. Experiments have also been made by Ohlmueller upon Spree water at Berlin, and the Tindal apparatus was tested at the Brussels exposition. In most of these cases the water was purified by sand filtration before the ozone treatment was applied, but the experiments of Ohlmueller were made upon unfiltered water from the Spree and upon distilled water to which known amounts of impurities were added. These tests showed that both the river water and the prepared samples were completely sterilized by the ozone in a few minutes, while sewage appeared to resist the action of the oxidizing agent.

The tests on the large scale in Europe were very successful, so far as the destruction of the bacteria was concerned, but the fact that the solid organic impurities had been previously removed by the filtration, renders these installations only partially conclusive.

Some few figures are given in this con-

nection as to the cost of purification by ozone, although fuller data in this respect would be welcome. In connection with the Paris tests, Dr. Repin, of the Pasteur Institute, says that where the water does not contain more organic matter than is represented by 0.004 gramme permanganate per litre, 5 cubic metres may be purified by the expenditure of 600 watts, this corresponding to about 0.6 h. p. per 1,000 gallons. Similar data at Brussels make the required energy about 0.5 h. p. per 1,000 gallons, and it was estimated that the cost of ozonizing water containing 0.1 gramme of organic matter per litre was less than 1 centime per cubic metre.

The experiments made by Mr. Soper, while conducted only on a laboratory scale, contribute some valuable information on the same lines as the larger experiences in Europe. These tests, of which a detailed account is given in the paper, included the removal of color and odor from various prepared samples, and also the treatment of Croton water with a view of determining the extent to which bacteria were removed. So far as odors and discolorations are concerned, the results were eminently satisfactory, the ozone removing all odor and nearly all discoloration from samples much more offensive than would be met in any water offered for drinking purposes. The bacteriological investigations, while not as conclusive as might be wished, gave interesting results, and showed that treatment of 15 to 20 minutes removed about 87 per cent. of the bacteria present. The chemical analyses of Croton water showed a notable degree of purification, and under the action of ozone nitrites disappeared, albuminoid ammonia and free ammonia were oxidized, and a material reduction in color effected.

The general conclusions as to the availability of ozone for water-purification are that by its use bacteria may be largely eliminated and unpleasant colors and odors removed. Since suspended matters are not removed nor destroyed, some form of filtration or sedimentation should precede ozonization, but such filtration need be only a simple straining.

The vital question of cost is not yet definitely determined, but some conclusions may be drawn from the figures given above.

Simplification of Battleship Construction.

ONE of the most important papers presented before the recent convention of the Society of Naval Architects and Marine Engineers was that by Mr. George W. Dickie, the well-known engineer of the Union Iron Works of San Francisco, dealing with the increasing complications in war-ships and suggesting how simpler arrangements might be adopted.

Everyone who has had to do with a modern war-ship has observed the enormous increase in complicated details, the proper working of which is essential to the serviceability of the vessel, and the care and supervision of which is a great burden upon the operating force. As is usual in such cases the arrangement of these details is not a matter possessing any unity of design, it is rather a growth, one thing having been added after another until the present crowded state of affairs has been reached, while the end is evidently not yet reached. Mr. Dickie believes that the present complicated condition is the result of two causes:

"First, uncontrolled growth of new devices for doing the many things for which mechanism is required on these vessels, without the new devices being considered reliable enough to supersede the old. Hence, duplication, and, in many cases triplication of apparatus for doing one thing, for which one good device alone should be used.

"Second, the system of divided control over the work, rendering it impossible to have a homogeneous design to begin with, that would enable the ship and all that is required of her to be treated as one machine, and provision made at the start for every function being considered with relation to every other function."

In discussing the best methods for overcoming the present excessive complication Mr. Dickie is recording only certain ideas which have occurred to him in his own struggles with the prevailing tangled condition of affairs, and disclaims any desire to propose any system of management in the construction of ships for the navy; but his ideas are undoubtedly of such value as to merit the careful consideration of marine constructors.

The principal suggestion made by Mr.

Dickie is that of providing a main tunnel or passage way, placed near the axis of the vessel and extending without obstruction from the chain lockers forward to the steering room aft, this tunnel to contain all the pipes, wires, and communicating mechanism of the ship. Such a tunnel would constitute the spinal cord of the vessel, and from it light, heat, power for auxiliaries, air, and orders of every description would be delivered to every department, by lateral branches only. This passage would have to be protected by armor from possibility of damage in action, and to be perfectly safe without division by water-tight doors, and from its location would be removed as far as possible from danger by stranding or collision. If a central station is used it should be formed by widening the central passage where the armored tube enters the roof of the passage from the conning tower. By making this tube large enough, all the speaking tubes, telegraph wires, steering-gear shafts, etc., etc., could be arranged so as to permit of examination or removal without affecting the others. The wires, pipes, shafts, and other means of communication could then be carried from the station along the central passage to the points where they would enter the compartments where they belong, no opening being required in any of the transverse bulkheads, and everything being in sight.

Mr. Dickie is favorably inclined toward the use of electricity on shipboard, provided it can be made so reliable as to require no duplicate power in reserve in case of breakdown. As he pertinently says: "it should either be pronounced reliable, and depended upon, or abandoned."

Two other important features in which simplification is both desirable and attainable, are discussed in Mr. Dickie's paper, viz., drainage, and fire-service.

The present drainage system is the result of a growth from the old hand pump service up through the numerous modifications of steam pumps, either independent or connected to the main engines, which circumstances have seemed to demand. Each device has been added to the preceding one without superseding it and the result is a wilderness of pipes and connections. Mr. Dickie would do away with all this complicated arrangements, and substitute two longitudinal drainage mains, one on each side of the central bulkhead, requiring only two holes through the transverse bulkheads, and run branches from these mains to the double bottoms and compartments above, requiring to be drained. The drainage would be effected by single-lift jack-head pumps, in sets of three, operated by electric motors, such a number running constantly as would be found necessary, and maintaining a vacuum in the drainage mains, so that any part containing water could be immediately dried by opening the connection. This is the simple way in which an engineer would drain a battle-ship if he had never seen how it had been done before.

The fire service is at present mixed up with the drainage and feed pump systems, and there are innumerable sea-valves and connections of the usual complicated kind. Mr. Dickie proposes to consider the water supply of a ship as he would that of a factory or a town. Two salt-water pumps of a capacity equal to the greatest emergency demand, arranged with compound cylinders so as to be capable of economical operation at partial load, could be placed in the engine room and used to maintain a pressure of 40 pounds upon a salt-water pipe-system for all the ordinary service of the ship, while in case of fire service both pumps could be operated with high pressure steam in both cylinders, giving 120 pounds pressure in the mains. This system would require but two sea suctions, outside of those required for the main-engine circulating water, and all the old complicated arrangements would disappear.

Mr. Dickie's paper is a strong appeal for common sense in the internal arrangements of war ships, and while all may not agree with his conclusions, it is very apparent that the whole subject should be approached in a spirit of independence of the conservative prejudices which have so much to do with the present unsatisfactory condition of affairs.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Architectural Ironwork.

The American Exchange National Bank Building, New York. Illustrated description of the novel features in the skeleton of a 40 x 100 ft. office building, 16 stories high. 1100 w. Eng Rec—Oct. 14, 1899. No. 30203.

Ceilings.

Suspended Ceilings and Metallic Furring. Illustrated description of the construction of deep-paneled dome and arch ceilings with wire-cloth backing. 1500 w. Eng Rec—Oct. 7, 1899. No. 30101.

Tests of Ceilings (Probelastung von Decken). M. Gary. A report of tests made at the Government Testing Laboratory at Charlottenburg, with illustrations of the methods of loading. 1500 w. Mitt aus den Kgl Tech Versuchsanstalt—Part III. 1899. No. 30460 G.

Columns.

The Designing of Columns for Freight and Passenger Sheds Exposed to Wind. J. J. Pensoff. A mathematical study of the effect of the wind. 700 w. Eng News—Oct. 5, 1899. No. 30066.

Dewey Arch.

The Dewey Arch, New York. Illustrated description of the structural features and methods of construction of the arch and triumphal columns erected temporarily in Madison Square, West. 3800 w. Eng Rec—Sept. 30, 1899. No. 29986.

Exposition.

The Austrian Government Building at the Paris Exposition of 1900 (Das Oesterreichische Reichhaus auf der Weltausstellung, Paris, 1900). With elevation, plans and section of the building from the drawings of the architect, Herr L. Baumann. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 6, 1899. No. 30420 B.

The Progress of the Works on the Champ de Mars (Etat d'Avancement des Travaux du Champ-de-Mars). Ch. Dantin. With numerous views of the partly completed buildings, including the chimney of the great power house. 2500 w. Génie Civil—Sept. 16, 1899. No. 30400 D.

The Works on the Esplanade des Invalides, the Seine and the Trocadero (Etat d'Avancement des Travaux de l'Esplanade des Invalides, des Berges de la Seine et du Trocadero). Ch. Dantin. Reviewing the present condition of the numerous buildings, with many illustrations. 2500 w. 1 plate. Génie Civil—Sept. 23, 1899. No. 30402 D.

Fire Protection.

The Safety of Theatre Audiences. Wm. Paul Gerhard. Reprinted from the publications of the British Fire Prevention Committee. Discusses the features of the building upon which the safety of the people depends. 5800 w. Am Arch—Oct. 21, 1899. Serial, 1st part. No. 30296.

Foundations.

Rapid Pneumatic Foundation Work. Illustrated description of wood caissons used in sinking piers for a New York building. 2200 w. Eng Rec—Oct. 28, 1899. No. 30394.

High Buildings.

The Highest Office Building in the World. Interesting features in the equipment of the Park Row Syndicate Building, in New York, are noted and illustrated. 2500 w. Engng—Sept. 22, 1899. No. 29963 A.

Pagoda.

Building an Indian Pagoda. J. Donnan, in *Indian Engineering*. A description of the work, with illustration. 2300 w. Stone—Sept., 1899. No. 29919 C.

Roof Trusses.

The Scissors Truss. F. E. Kidder. Illustrated discussion of the principles to be followed in designing them. 1100 w. Eng Rec—Oct. 7, 1899. No. 30103.

Stables.

A Suburban Stable and Casino. Illustrated description of a stable in the suburbs of Philadelphia which not only accommodates the horses and cows, but is fitted with living rooms for the employés, billiard and card rooms, bowling alley, amusement hall and musical studio. 2200 w. Eng Rec—Oct. 7, 1899. No. 30102.

Steeples.

The Computation of Octagonal Pyramidal Towers (Die Berechnung Achtseiliger Turmpyramiden). H. Müller-Breslau. A very complete mathematical treatment for the construction of steeples of framed structural metal, with diagrams showing the best methods of framing and bracing. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1899. No. 30423 D.

Tenements.

Tenement House Requirements in New York. Plan of required and recommended construction to secure better ventila-

tion and light, with editorial note. 200 w. Eng Rec—Sept. 30, 1899. No. 29992.

Underpinning.

Underpinning Without Supports. Illustrates and describes the method of supporting a heavy wall, 94 feet high, carried less than 5 feet below the curb line, while an adjacent lot was excavated 9 feet below its footing. 1500 w. Eng. Rec—Sept. 30, 1899. No. 29991.

HEATING AND VENTILATION.

Ceiling.

The Form of Ceilings in Connection with Ventilation, Heating, and Acoustics (Die Form der Saaldecken in ihren Beziehungen zur Luftbewegung, Heizung, und Akustik). H. C. Nussbaum. A general discussion of the problems involved. 1200 w. Gesundheits-Ingenieur—Sept. 15, 1899. No. 30445 B.

Church-Heating.

The Heating of Churches, Especially the Heating of the Cathedral of Ulm. (Ueber Beheizung von Kirchen, insbesondere über die Beheizung des Ulmer Münsters). Prof. Rietschel. A very complete account of the introduction of low-pressure steam heating into a mediæval cathedral. Two articles, 6000 w. Gesundheits-Ingenieur. Sept. 15, 30, 1899. No. 30444 each B.

Furnace Heating.

Furnace Heating. William G. Snow. Illustrated detailed description. 2700 w. Met Work—Oct. 7, 1899. Serial, 1st part. No. 30059.

Heating Plant.

Some Interesting Details of a Heating Plant. Illustrated description of the plant for heating a number of large detached buildings at East Cambridge, Mass.; the central station consists of two engine houses and a boiler plant, all in detached buildings. 1000 w. Eng Rec—Oct. 14, 1899. No. 30204.

High Pressure.

The Disfavor Shown by Fire Insurance Companies to High Pressure Heating Apparatus. A. E. Grindrod. Read before the British Inst. of Heat and Ven. Engs. Considers the causes of disfavor and how to remove them. Also discussion. 3000 w. Heat & Ven—Sept., 1899. No. 29945.

House of Representatives.

Ventilation of the Hall of the House of Representatives and the South Wing of the Capitol, Washington, D. C. From a report of S. Homer Woodbridge. Discusses the advantages of upward and downward ventilation, favoring the upward system. Ill. 9500 w. Heat & Ven—Oct., 1899. Serial, 1st part. No. 30398.

Institution.

Heating and Ventilating St. Joseph's Home, Troy, N. Y. Describes a combination system of direct and indirect hot water radiation with some use of direct-indirect. Ill. 1500 w. Heat & Ven—Oct., 1899. No. 30397.

Residence.

A Hot-Water Furnace for Heating a Residence. Illustrated description of a furnace which supplies both hot water and warm air. 900 w. Eng Rec—Oct. 28, 1899. No. 30396.

Walls.

The Construction of Walls and Ceilings with Regard to Their Influence on Warming (Die Bauart der Wände und Decken in ihrem Einfluss auf die Heizung). H. C. Nussbaum. Showing the influence of walls upon the efficiency of heating apparatus. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1899. No. 30446 B.

Warming.

Practice in Warming (Aus der Heizungspraxis). F. Halbig. Discussing especially the most desirable features of boilers for steam heating. 2000 w. Gesundheits-Ingenieur—Oct. 15, 1899. No. 30447 B.

PLUMBING AND GAS FITTING.

Gas Fitting.

Pointers on Practical Gas-Fitting. Calls attention to important things in properly fitting a house. 1300 w. San Plumb—Oct. 2, 1899. Serial, 1st part. No. 30060.

Residence Plumbing.

An Elaborate System of Residence Plumbing. Illustrates special features in an unusually expensive New York residence. 4000 w. Eng Rec—Oct. 21, 1899. No. 30290.

Sanitation.

Domestic Sanitation. W. Watkins. Read at Sanitary Inspectors' Conference, England. A discussion of appliances in common use, and ways in which they should be improved. 3500 w. Plumb & Dec—Oct. 2, 1899. No. 30156 A.

MISCELLANY.

Estimating.

Estimating. John Lyman Faxon. Gives illustrations of estimating and discusses the proper basis. 2000 w. Br Build—Oct., 1899. No. 30377 C.

Public Health.

Engineering and Architecture. James Lemon. Discusses those branches which particularly affect public health, as pure water, sewerage, pure air, healthy dwellings, etc. 4500 w. Jour San Inst—Oct., 1899. No. 30292 F.

CIVIL ENGINEERING

BRIDGES.

Albany Bridge.

The Maiden Lane Bridge, Albany, N. Y. Illustrated description of a double-track bridge of one draw span 269 ft. long, four fixed spans of 181½ ft., and plate-girder approaches, designed to carry the heaviest trains of the New York Central line without checking speed. The type of construction differs in a number of respects from usual practice. 2700 w. Eng Rec—Oct. 28, 1899. No. 30389.

Arch.

The Arch. A statement of the development of the theory of the arch of masonry and metal. 1000 w. Eng Rec—Oct. 28, 1899. No. 30386.

The Development of the Arch Principle. Discusses the principle of the arch in its relation to metallic structures, citing examples and considering their merits. 2200 w. Engr, Lond—Oct. 6, 1899. No. 30229 A.

Atbara.

The Soudan Railroad and the Atbara Bridge. Extracts from the speech of Lord Kitchener at the opening of this bridge. 800 w. R R Gaz—Sept. 29, 1899. No. 29939.

Bridge Design.

Wheel Concentrations and Fatigue Formulas in Bridge Design. Continued discussion. 4400 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30353 E.

Hinged Arch.

Comparison of Weights of a Three-Hinged and a Two-Hinged Spandrel-Braced Parabolic Arch. Henry S. Jacoby. Continued discussion of paper by C. W. Hudson. 2000 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30352 E.

Philadelphia.

The Eighteenth Street Bridge, Philadelphia. Illustrated description of the details of a heavy plate-girder bridge over a railway subway. 1000 w. Eng Rec—Oct. 14, 1899. No. 30191.

Plate-Girder.

A Long Double-Track Plate-Girder Span. Illustrated description of a bridge 116 ft. long, carrying express trains at full speed on a curved track. 1500 w. Eng Rec—Oct. 21, 1899. No. 30278.

Protection Walls.

Concrete Protection Walls for Bridge Supports. An illustrated description of the protection against dislodgement by derailed cars furnished for the depressed tracks in Chicago. 600 w. Ry & Engng Rev—Oct. 14, 1899. No. 30211.

Reinforced Concrete.

A Concrete and Iron Bridge at Oconomowoc, Wis. Illustrates and describes a small, but interesting, arch bridge of this type. 700 w. Eng News—Oct. 19, 1899. No. 30255.

An Early Design for a Long-Span Concrete-Steel Arch Bridge. Thomas C. Clarke. Brief illustrated description of a design once accepted for the Washington Bridge over the Harlem River, in New York City. 400 w. Eng News—Sept. 28, 1899. No. 29956.

Timber.

The Life of Timber Employed in Railway Bridges in the United States. Tabulated report presented at convention of Assn. of Ry. Supts. of Bridges and Buildings. 400 w. Eng News—Oct. 26, 1899. No. 30372.

Trestle.

The Thomson Run Bridge. Brief description, with engravings, of a fine trestle bridge on the line of the Monongahela St. Ry. Co. 200 w. R R Gaz—Oct. 6, 1899. No. 30083.

Viaduct.

Floor Details of a City Viaduct. Illustrated description of a shallow floor system with special protection against gases from locomotives passing below. 1000 w. Eng Rec—Sept. 30, 1899. No. 29990.

CONSTRUCTION.

Foundations

See Architectural Engineering, Construction.

Groined Arch.

The Groined Arch as a Covering for Reservoirs and Sand Filters: Its Strength and Volume. Continued discussion of paper by Leonard Metcalf. 2000 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30351 E.

Reinforced Concrete.

Computations for Ribbed Beams of Iron and Concrete on the Hennebique System (Berechnung der Gerippten Betoneisenträger, System Hennebique). Max R. v. Thullie. A mathematical treatment of the proportions for concrete girders with imbedded iron rods. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 15, 1899. No. 30416 B.

Retaining Walls and Bridge in Reinforced Concrete on the Quai Debilly (Murs de Soutenement et Pont en Béton Armé du Quai Debilly). Showing the

practical application of the Hennebique system to an important piece of retaining wall construction at the Paris Exposition. 1200 w. Génie Civil—Sept. 30, 1899. No. 30406 D.

See Civil Engineering, Bridges.

Retaining Walls.

Computations for Retaining Walls (Calcul des Murs de Soutènement). S. Pichault. A very complete mathematical treatment of the pressure of earth upon retaining walls for various surchargings; with bibliography of authorities. 15000 w. Mem de la Soc Ing Civ de France—Aug., 1899. No. 30466 G.

Experiments on Earth Pressure Against Retaining Walls. A. A. Steel. Abstract of a graduating thesis at the University of Nebraska. An account of experiments to determine facts. Ill. 3000 w. Eng News—Oct. 19, 1899. No. 30260.

Roof Trusses.

See Architectural Engineering, Construction.

Similar Structures.

Similar Structures and Machines. Archibald Barr. Read before the Inst. of Engs. and Shipbuilders in Scotland. Recalls principles brought forward in a paper read in 1875 by James Thomson, giving further illustrations and applying similar reasoning to questions involving kinetic as well as static actions. 3700 w. Engng—Oct. 13, 1899. Serial, 1st part. No. 30322 A.

Subway.

The Philadelphia Subway and Tunnel. An illustrated account of the work on the Pennsylvania avenue subway and tunnel, and the engineering problems met. 2800 w. Sci Am—Oct. 21, 1899. No. 30249.

Underpinning.

See Architectural Engineering, Construction.

Water Main.

Laying a 6-in. Water Main Across Havana Harbor. Howard Egleston. Describes the plan adopted. Ill. 1800 w. Eng News—Oct. 12, 1899. No. 30181.

Waterproofing Masonry.

Waterproofing Tunnel Masonry. A statement of the methods adopted for the New York rapid-transit tunnels, involving the use of felts and asphalt, brick and asphalt, or asphaltic concrete. 1400 w. Eng Rec—Oct. 28, 1899. No. 30391.

HYDRAULIC AND MARINE.

Breakwater.

The Marquette Breakwater and Duluth Ship Canal Piers. Illustrated description of the method of making, supporting and placing enormous blocks of concrete. 5000 w. Eng Rec—Oct. 28, 1899. No. 30390.

Canals.

Failure of Canal Bank. Illustrates and describes the collapse of an embankment in England, at Dudley Port. 1200 w. Engr, Lond—Sept. 22, 1899. No. 29978 A.

Mechanical Traction on Canals. Historical review of the various methods tried. 4000 w. Engr, Lond—Sept. 29, 1899. No. 30136 A.

Notes on the History of the Danube Canal at Vienna (Beitrag zur Geschichte des Weiner Donaucanals). A. Prokesch. A review of the improvements in the canalized arm of the Danube at Vienna since the early works in 1688. 4500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1899. No. 30435 D.

The Canal from the Lake of Thun to Interlachen (Der Schiffahrtskanal vom Thunersee bis Interlaken). A very complete account of the correction works on the river Aar and the construction of a navigable water-way to Interlaken, with map and profiles. Four articles, 7000 w. Schweizersche Bauzeitung—Sept. 16, 23, 30, Oct. 14, 1899. No. 30431 each B.

The Dortmund-Ems Canal (Le Canal de Dortmund à l'Ems). G. Henry. A very full account of the engineering features of the canal, with numerous illustrations and drawings of the lift at Henrichenburg. 4500 w. 1 plate. Génie Civil—Oct. 7, 1899. No. 30407 D.

The Lubeck Canal. From *Ueber Land und Meer*. Illustrated description of this canal and the difficulties met in its construction. 1600 w. Sci Am Sup—Oct. 28, 1899. No. 30362.

Water Transport Between the North of France and Paris (A Propos des Transports par Eau entre le Nord et Paris). A. de Bovet. A discussion of the elements of the cost of the water transport and the best method of reducing it. 4000 4. Mem de la Soc Ing Civ de France—Aug., 1899. No. 30465 G.

Dams.

Lake Levels—Proposed Dam in the Niagara. George G. Wisner. Discusses the advantage and the methods. 3400 w. Marine Rev—Oct. 19, 1899. No. 30297.

Municipal Ownership at Austin, Texas. W. D. Hornaday. Illustrates and describes the serious condition of the great dam across the Colorado River. 1000 w. Elec Wld & Engr—Oct. 14, 1899. No. 30503.

Drainage Canal.

The Salient Features of the Chief Engineer's Annual Report of the Drainage Canal of the Sanitary District of Chicago

for 1898. Isham Randolph. Ill. 5000 w. Jour W Soc of Engs—Aug., 1899. No. 30376 D.

Dredges.

New Russian Dredge. A description of the dredge for the Volga ordered by the Russian government, with report of tests. 3800 w. U. S. Cons. Repts, No. 564—Oct. 27, 1899. No. 30375 D.

Suction Dredge and Collector (Saugpumpenbagger mit Sammelbehälter). An illustrated description of the new dredge built for use in the port of Antwerp. 1200 w. Schweizerische Bauzeitung—Sept. 16, 1899. No. 30432 B.

Dry Docks.

Algiers Floating Dry Dock. A description of the floating structure being built at Sparrow's Point, Md. 900 w. Marine Rev—Sept. 28, 1899. No. 30028.

Four Immense Dry Docks—League Island, Mare Island, Boston and Portsmouth. Brief illustrated description. 1200 w. Marine Rev—Sept 28, 1899. No. 30026.

Filtration.

A Few Words Upon Water Filtration. H. W. Clark. Some results at Lawrence, Mass., are given. 2000 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30049 E.

Relative Applicability of Sand and Mechanical Filters. George W. Fuller. Outlines the work and the evidence now available upon these two methods of purification, and emphasizes the necessity of studying each supply. Also discussion. 9000 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30046 E.

The East Providence Filter. Illustrated description of a mechanical filter plant, with a summary of the results of tests made during five months' regular operation. 800 w. Eng Rec—Oct. 21, 1899. No. 30279.

The Improvement of the Philadelphia Water Supply. Illustrated description of the filters recommended by the expert commission of 1899. 1000 w. Eng Rec—Oct. 7, 1899. No. 30098.

The Mechanical Filtration of Water. A review of experimental results obtained at Cincinnati by G. W. Fuller. 1800 w. Eng Rec—Oct. 7, 1899. No. 30099.

Ground Water.

The Removal of Iron from Ground Water. Illustrated description of several plants built in the U. S. for this purpose, with figures of the efficiency of their operations. 1300 w. Eng Rec—Sept. 30, 1899. No. 29988.

Harbors.

Proposed Harbor Improvements at Victoria, B. C. Map with explanation of proposed improvements, with cost and particulars. 1400 w. Can Arch—Oct., 1899. No. 30360 C.

The 1000-H. P. Ladder Dredge for the Vladivostock Harbor Improvement Work, Russia. Illustrated description. 700 w. Eng News—Oct. 5, 1899. No. 30067.

The Harbor of Dortmund and Its Traffic (Der Hafen von Dortmund und sein Bisheriger Verkehr). J. Riedel. A note concerning the traffic and handling facilities of the port of Dortmund considered in connection with the opening of the Dortmund-Ems Canal. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 29, 1899. No. 30419 B.

Lock.

The Floating Guard for the Lock of the Wien at Weidlingau-Hadersdorf (Der Schwimmrechen vor der Schleuse der Wienfluss regulirung in Weidlingau-Hadersdorf). Describing and illustrating the floating guard used to intercept floating driftwood and other matter. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 29, 1899. No. 30418 B.,,

Organisms.

Asterionella—Its Biology, Its Chemistry, and Its Effect on Water Supplies. George C. Whipple and D. D. Jackson. A discussion of the conditions of growth of this diatom, the manner in which it imparts an offensive odor to water, and the most effective method of destroying it. 7500 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30044 E.

Chlamydomonas in Spot Pond. Frederick S. Hollis and Horatio N. Parker. An illustrated account of an organism that imparts an unpleasant taste and odor to the water. 1500 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30045 E.

Organisms Which Cause Unpleasant Odors and Tastes in Water Supplies. W. T. Sedgwick. Remarks on micro-organisms and a review of work published by George C. Whipple on "The Microscopical Examination of Drinking Water." 4300 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30047 E.

Reinforcing Wells.

Reinforcing a Well by Galleries. An account of the method of driving tunnels through water-bearing strata at the foot of a well. 1100 w. Eng Rec—Oct. 7, 1899. No. 30100.

Reservoir.

Denver's Great Storage Reservoir. Brief illustrated description. 1200 w. Fire & Water—Oct. 28, 1899. No. 30399.

Rivers.

River Hydraulics. James A. Seddon. An outline of the methods and results of

a systematic study of data taken on the Mississippi River and its tributaries. 5500 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30348 E.

The Improvement of the Mouths of the Volga. Brief account of the commencement of a series of improvements in the navigation. 900 w. Engr, Lond—Oct. 13, 1899. No. 30312 A.

Sea Wall.

The Dymchurch Wall and Reclamation of Romney Marsh. Edward Case. Read before the British Assn. Historical account, with description of the method of building up a foreshore. 1700 w. Engr, Lond—Oct. 20, 1899. No. 30519 A.

Water Purification.

Sedimentation Basins for Water Works. Wynkoop Kiersted. Illustrated description of a type of basin which has been found useful in clarifying muddy water. 1700 w. Eng Rec—Oct. 28, 1899. No. 30392.

The Purification of Drinking Water by the Use of Ozone. George A. Soper. Reviews the work done by investigators and gives an account of experiments by the writer. 6300 w. Eng News—Oct. 19, 1899. No. 30256.

Water Supply.

Albany's Water Supply, and That of Her Neighbors. James D. Featherstonhaugh, in *Albany Medical Annals.* On the pollution of the Mohawk and Hudson rivers and the need of securing water from other sources, or properly purifying it. 2400 w. San—Oct., 1899. No. 29983 D.

Report of the Commission on the Improvement of the Philadelphia Water Supply. A review of the report of expert engineers appointed to investigate the question and report on plan for immediate improvement and extension. 4000 w. Eng News—Oct. 5, 1899. No. 30068.

Some Difficulties in Obtaining a Water Supply. Willis J. Milner. Read at Buffalo meeting of the Am. W. Wks. Assn. An illustrated account of the supply at Birmingham, Ala. 800 w. Fire & Water—Sept. 30, 1899. Serial, 1st part. No. 30000.

Some Results of the Systematic Examination of the Water of Public Water Supplies. X. H. Goodnough. An account of this work in Massachusetts and the information gained. Also discussion. 7000 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30048 E.

The Improvement of the Philadelphia Water Supply. Illustrated review of a report by Rudolph Hering, J. M. Wilson and S. M. Gray on the possible sources of a supply, and recommending filtration of river water, with notes on the allowable consumption of water and the growth of cities. 3200 w. Eng Rec—Sept. 30, 1899. No. 29987.

The Reduction of Water Waste. Morris R. Sherrerd. Before the A. S. M. I. Describes the methods at Newark and gives their results. 800 w. Eng Rec—Oct. 14, 1899. No. 30199.

Water Rates. August Herrmann. Before the A. S. M. I. An analysis of the rates in cities over 80,000 population, showing the variation in the manner of making the charges, their amount, and outlining some of the reasons for the difference in prices. 2100 w. Eng Rec—Oct. 14, 1899. No. 30200.

Water Tower.

The West Arlington Standpipe, Baltimore. Illustrated description of a standpipe with a masonry protecting tower in which special attention was paid to the architectural effect of the completed structure. 700 w. Eng Rec—Sept. 30, 1899. No. 29989.

Weirs.

A Modification of Foote's Irrigation Excess Weir or Spillbox. Describes modifications recently made by W. Newbrough. 700 w. Eng News—Oct. 26, 1899. No. 30371.

The Latest Researches of M. Bazin upon the Flow of Water over Weirs (M. Bazin's Neuer Untersuchungen über den Abfluss an Ueberfällen). R. Siedek. A resumé of Bazin's paper in the *Annales des Ponts et Chaussées.* 3000 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1899. No. 30436 D.

MATERIALS.

Asphalt.

Asphalt and Related Hydro-carbons. J. Ohly. The nature and origin, deposits and interesting history of its use. 1400 w. Min Rept—Oct. 5, 1899. Serial. 1st part. No. 30154.

California Asphaltum. Arthur Lakes. Describes some of the principal deposits and the methods of refining and handling the mineral. 1500 w. Mines & Min—Oct., 1899. No. 30145 C.

Cement.

Hydraulic Cement for Reservoirs and Canal Works. Illustrates and describes work on the continent of Europe. 1100 w. Fire & Water—Sept. 30, 1899. No. 30001.

Hydraulic Cement in the United States. Describes the works of the James River Cement Co. 1500 w. Engr, Lond—Sept. 29, 1899. No. 30139 A.

The Effect of Salt Water on Cement. A. S. Cooper. Gives results of experiments showing conclusively the ill-effect of salt in gauging mortar. 1500 w. Jour Fr Inst—Oct., 1899. No. 30089 D.

The Elasticity of Portland Cement. Describes experiments made at Liverpool by W. L. Brown. 1800 w. Eng Rec—Oct. 28, 1899. No. 30395.

Variations in Volume of Portland Cement Mortars (Variations de Volume des Mortiers de Ciment de Portland). M. Considère. A communication to the French Academy giving the result of experiments made to determine the influence of the expansion of cement upon reinforcements of imbedded metal. 2000 w. Comptes Rendus—Sept. 18, 1899. No. 30437 D.

Concrete.

The Choice of Materials for and the Manufacture of Concrete for Engineering Work. Ira O. Baker. Extracts from advance sheets of the ninth edition of "A Treatise on Masonry Construction." 4800 w. Eng News—Sept. 28, 1899. No. 29957.

Forests.

Forest Management in Maine. Austin Cary. Discusses the methods and work of the forester. 8800 w. Jour Assn of Engng Socs—Aug., 1899. No. 29916 C.

Protective Coatings.

See Marine Engineering.

Seasoning.

The Rapid Seasoning of Wood by Electricity (La Sénilisation Rapide des Bois par l'Electricité). J. A. Montpellièr. A description of the Nodon & Bretonneau process, by which the sap is rapidly replaced by a preservative solution by means of an electric current. Three articles. 4500 w. L'Electricien—Oct. 7, 14, 21, 1899. No. 30485 each B.

Timbers.

Life of Bridge Timbers and Advisability of Protecting Same from the Weather. Extracts from a committee report presented at the Detroit meeting of the Assn. of Ry. Supts. of Bridges and Buildings. Ill. 1700 w. Ry & Engng Rev—Oct. 21, 1899. No. 30326.

Some Notes on Fireproofing and Preserving Timber. Sherard Cowper-Coles. Reviews various processes and experiments. 2800 w. Ind & Ir—Oct. 20, 1899. No. 30523 A.

MEASUREMENT.

Frameworks.

The Exact Design of Statically Indeterminate Frameworks—An Exposition of Its Possibility, but Futility. Frank H. Cilley. An examination of certain questions in connection with ideal frameworks, of practical importance because at the foundation of actual designs. Mathematical. 14800 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30347 E.

Stresses.

The Problem of Struts with Lateral Loads. B. W. Head. A mathematical study. 2200 w. Engr Lond—Sept. 22, 1899. No. 29975 A.

Vienna.

The Plan of Vienna at the Beginning of the XVIII. Century (Die Wiener Stadtpläne aus dem Anfange des XVIII. Jahrhunderts). S. Wellisch. An interesting comparison of old surveys with modern data, with a discussion of the mean errors of the earlier maps. Two articles. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 6, 13, 1899. No. 30421 each B.

MUNICIPAL.

Assessments.

Local Assessments. A statement of the results of an endeavor in Jersey City to proportion the cost of local improvements equitably on property-holders and the city at large. 1000 w. Eng Rec—Oct. 14, 1899. No. 30201.

Garbage.

Garbage Disposal and Street Cleaning. W. C. Woodward. Read before the A. S. M. I. An outline of the best methods of securing satisfactory results. 1100 w. Eng Rec—Oct. 14, 1899. No. 30198.

Garbage Disposal at Cincinnati. Describes the method of collecting the garbage by city employés and delivering it to a company for disposal by reduction. 700 w. Eng Rec—Oct. 14, 1899. No. 30205.

Garbage Disposal at Toronto, Ont. Illustrated description of the method of collecting and of the cremators built by the city. 1300 w. Eng Rec—Oct. 21, 1899. No. 30285.

Havana.

The Engineering and Sanitary Renovation of Havana under U. S. Military Government. Abstract of report by Gen. Ludlow of the extensive and excellent work, with editorial comment. 6000 w. Eng News—Oct. 12, 1899. No. 30183.

Municipal Improvements.

The Importance of Municipal Improvements. A statement by W. P. Lewis, in an address before the Am. Soc. of Munic. Imp. at the Toronto meeting, of the magnitude of public works in the U. S. 1000 w. Eng Rec—Oct. 14, 1899. No. 30192.

New Orleans.

Drainage and Sewerage of New Orleans. A. N. Bell, in the *Times-Democrat*. Historical account of work and its effect on public health. 7500 w. San—Oct., 1899. No. 29982 D.

Pavements.

Asphalt Fluxes. W. H. Broadhurst.

A report read before the A. S. M. I. of studies made at the Brooklyn municipal laboratory of the value of fluxes for bitumen employed in pavements. 1000 w. Eng Rec—Oct. 14, 1899. No. 30196.

Brick Pavements. L. M. Hastings. A statement before the convention of the A. S. M. I. of the results of an inspection of such work in a number of cities. 1100 w. Eng Rec—Oct. 14, 1899. No. 30193.

Pavements Between Street Railway Tracks. Charles H. Rust. Read before the A. S. M. I. Illustrated description of the construction employed by Toronto, Ont., where the tracks are built and owned by the city. 1300 w. Eng Rec—Oct. 14, 1899. No. 30195.

Paving Brick and Brick Pavements. H. J. March. Gives the history and progress of brick-making, and considers brick pavements, their cost, durability, etc. 10500 w. Jour Assn of Engng Socs—Aug., 1899. No. 29918 C.

Street Railways and Street Pavements. Summary of a report by a committee of the Am. Soc. of Munic. Imp. on the means of keeping pavements about tracks in repair. 2100 w. Eng Rec—Oct. 14, 1899. No. 30197.

The Life of Pavements. Review of a paper by G. W. Tillson on the relative destructive action of various agents, and the life to be expected of different paving material. 2600 w. Eng Rec—Oct. 21, 1899. No. 30282.

Wood Pavements in Indianapolis. M. A. Downing. A description of the creosoted wood blocks and the manner of laying them. Read before the A. S. M. I. 1000 w. Eng Rec—Oct. 14, 1899. No. 30194.

Public Baths.

Baths for the Poorest. W. R. Court. From a report on the baths proposed for Liverpool, dealing with the plans and methods of administration. 1800 w. Arch. Lond—Sept. 29, 1899. No. 30120 A.

Reports.

The Tabulation of Municipal Statistics. Summary of a report to the Am. Soc. of Munic. Imp. on forms for giving municipal statistics in order that the figures of different cities may be comparable. 3000 w. Eng Rec—Oct. 14, 1899. No. 30202.

Sanitary Engineering.

Inaugural Address by Sir William Henry Preece. Full address discussing the principles of sanitary engineering. 8000 w. Jour San Inst—Oct., 1899. No. 30291 F.

Sanitation.

The Renovation of Havana. An account of the work done in cleaning the city during the first six months of American occupation. 3100 w. Eng Rec—Oct. 7, 1899. No. 30097.

Sewage Disposal.

Bacteriological Sewage Works at Hampton-on-Thames. An illustrated description of the works and system, with an account of the difficulties encountered. 1200 w. Engr, Lond—Oct. 20, 1899. No. 30518 A.

Experience with Bacteria Beds. A report to the Sanitary Institute on the water capacity, size of filtering material, and the influences on organic nitrogen. 2300 w. Eng Rec—Oct. 21, 1899. No. 30281.

Recent Crossness Experiments with Bacterial Sewage Treatment. Gives results of passing sewage intermittently through beds filled to depths of 4, 6, and 13 ft. with coke of the size of English walnuts. 3000 w. Eng Rec—Oct. 28, 1899. No. 30393.

Sutton Sewage Disposal Works. The bacterial process has been for some time in operation and an account is given of the results obtained and the manner of obtaining them. Ill. 2800 w. Engr, Lond—Oct. 13, 1899. No. 30313 A.

The Bacterial Treatment of Crude Sewage at Crossness. Conclusions concerning the experimental intermittent treatment of London crude sewage in the coke beds, as taken from the report of the London County Council. 4800 w. Engr, Lond—Oct. 20, 1899. No. 30515 A.

The Bacterial Treatment of Crude Sewage. Editorial on the methods used at various places and experiments made. 2200 w. Engng—Oct. 13, 1899. No. 30319 A.

The General Distribution of the Sewage of Paris (L'Emissaire Général des Eaux d'Egout de la Ville de Paris). E. Fourrey. A very complete account of the system by which all the sewage of Paris is delivered to the irrigation area below the city. Interesting data about reinforced concrete construction are given. 4000 w. Revue Technique—Sept. 25, 1899. No. 30413 D.

The General Distribution of the Sewage of Paris (L'Emissaire Général des Eaux d'Egout de la Ville de Paris). E. Fourrey. The second paper is devoted to the sewage pumping machinery and the purification beds. 2500 w. Revue Technique—Oct. 10, 1899. No. 30415 D.

The Septic Tank Process of Sewage Treatment at Exeter and Yeovil, England. Letter to the editor describing the process so successfully carried out, with brief history of the place. Ill. 3500 w. Eng News—Oct. 26, 1899. No. 30374.

Street Lighting.

See Electrical Engineering, Lighting.

Streets.

Street Grades. Considers the importance of fixing grades while the territory is not built up, based on the situation now existing in New York. 700 w. Eng Rec—Oct. 28, 1899. No. 30387.

Tampico.

Water Works and Sewerage in Tampico. Gives a translation of advertisement for bids on work of estimated value of $800,000. 600 w. U. S. Cons Repts, No. 548—Oct. 9, 1899. No. 30085 D.

Wastes.

Disposal of Wastes from Country Homes. H. C. Patterson. Illustrates and describes inexpensive plans and methods. 400 w. Dom Engng—Oct., 1899. No. 30272 C.

MISCELLANY.

Education.

Sir Andrew Noble on the Best Education for Engineers. Inaugural address given at the City and Guilds Central Technical College, England. Presents the necessity of acquiring a sound general education, and the necessity of basing practical work on theoretical knowledge. 3800 w. Nature—Oct. 5, 1899. No. 30221 A.

Some Unrecognized Functions of State Universities. J. B. Johnson. Condensed from address on the occasion of inauguration as Dean of the College of Mechanics and Engineering of the Univ. of Wisconsin. 3500 w. Eng News—Oct. 26, 1899. No. 30369.

The Best Education for an Engineer. W. E. A. A critical review of the address of Sir Andrew Noble. 2500 w. Nature—Oct. 12, 1899. No. 30302 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Pacific Cable.

The Proposed Pacific Cable Routes. Harrington Emerson. A masterly comparison of the practicability, cost, working expense, commercial and political value and financial expectations of all the proposed lines. Urges that broad economic wisdom, not narrow nationalism, be followed in choosing a route. 6000 w. Engineering Magazine—Nov., 1899. No. 30494 B.

Space Telegraphy.

Observations on the Operation of Wireless Telegraphy on La Grande Duchesse. William Maver, Jr. Gives an interesting account of the work during the recent yacht races. 1500 w. Elec Wld & Engr—Oct. 14, 1899. No. 30500.

Wireless Telegraphy. John Trowbridge. A history of the new life of the transformer and its possibilities. Ill. 4000 w. Ap Pop Sci M—Nov., 1899. No. 30342 D.

Statute.

The Telegraph Act, 1899. Editorial discussion of the act passed in England, Aug. 9, 1899, explaining the nature of the alterations it is likely to effect. 3000 w. Engng—Sept. 22, 1899. No. 29966 A.

Telegraph Survey

The Pioneer Telegraph Survey of British Columbia. P. J. Leech. An interesting illustrated account of the work in connection with the line that was planned to extend through British Columbia and Alaska to Behring Strait, and continuing to St. Petersburg, Russia. 6800 w. B. C. Min Rec—Aug., 1899. No. 30057 C.

Telephone Fuse.

Fuses for Telephone Conductors (Schmelzsicherungen in Fernsprechleitungen). K. Strecker. Describing a system of fuses for the protection of telephone conductors from the currents of tramway systems. 3000 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30474 B.

Telephony.

Some Instances of Composite Transmission and Compound Telephony. Thomas D. Lockwood. Read at the Wilmington meeting of the Assn. of Ry. Telegraph Supts. Illustrates and describes various arrangements for the simultaneous transmission of two or more telephonic messages over the same wires, or for sending telegraphic and telephonic messages over the same lines at the same time. 3500 w. Elec Rev, N. Y. —Oct. 4, 1899. No. 30071.

Visual Telegraphy.

The Telectroskope (Das Telektroskop). A description of the invention of Jan Szczepanik, by which it is claimed that visual images may be telegraphically transmitted. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1899. No. 30424 D.

DISTRIBUTION.

Circuits.

The Systematic Arrangement of Circuits in an Electrical Plant. William Baxter, Jr. Suggestions and illustrated description. 2000 w. Am Mach—Sept. 28, 1899. No. 29927.

Nuremberg.

The Distribution of Electrical Energy at Nuremberg (Distribution d'Energie de Nuremberg). H. Martin. With numerous illustrations of the generating plant and a full account of the operation of this very successful installation. 3000 w. 1 plate. Génie Civil—Sept. 30, 1899. No. 30404 D.

Power Subdivision.

Electric Power Distribution and the Small Consumer. Dr. Louis Bell. Showing how electric distribution may become a corrective of the centralization due to steam, and giving examples from recent continental practice of the redistribution of industry. 3500 w. Engineering Magazine—Nov., 1899. No. 30495 B.

Transformer Losses.

Switching Device for Preventing Losses in Unloaded Transformers (Schaltvorrichtung zur Vermeidung der Leerlaufsarbeit in Unbelasteten Transformatoren). H. Müller. A device for throwing the primary or secondary circuit of a transformer alternately in or out automatically. 1000 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30472 B.

Wiring.

Interior Alternating Current Wiring. R. W. Lohmann. A résumé of the principles governing the drop in a conductor traversed by an alternating current, with editorial. 4000 w. Elec Wld and Engr—Oct. 21, 1899. No. 30275.

Protection of Interior Wiring from High Potential Currents. Warren B. Reed and Lyman C. Reed. Discusses the efforts made to solve this problem and shows what is needed. 2400 w. Elec Wld & Engr—Oct. 28, 1899. No. 30385.

ELECTRO-CHEMISTRY.

Atomic Weight.

The Relation of the General Properties of Elements to Their Atomic Weight (Ueber die Beziehungen der Allgemeinen Eigenschaften der Elemente zu deren Atomgewichten). W. Sander. A general review of the theory of Mendelejew and his followers, and its application to practical electrochemistry. 2000 w. Elektrochemische Zeitschr—Oct., 1899. No. 30480 G.

Electrolytes.

The Decomposition of Solid and Fused Electrolytes (Ueber die Zersetzungsspannung Fester und Geschmolzener Elektrolyte). C. C. Garrard. A preliminary report upon a number of investigations made at the Göttingen laboratory under the direction of Prof. Nernst. 1500 w. Zeitschr f Elektrochemie—Sept. 28, 1899. No. 30478 G.

Laboratory.

The Arrangement of the Central Laboratory of the Stolberg and Westphalia Company (Elektrolytische Einrichtung des Central-Laboratorums der Aktien-Gesellschaft zu Stolberg und in Westfalen). H. Nissenson. With plans of well-arranged electrolytic laboratory, and illustrations of apparatus. 2000 w. Zeitschr Elektrochemie—Oct. 5, 1899. No. 30479 G.

Metallurgy.

Progress in Electrometallurgy and Analysis (Fortschritte auf dem Gebiete der Elektro-Metallurgie und Analyse). Dr. H. Paweck. A very complete record of the work of the past few years, with bibliography. Five articles. 8000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept, 2, 9, 16, 23, 30, 1899. No. 30448 each B.

Some Recent Applications of Electro-Metallurgy to Mechanical Engineering. Sherard Cowper-Coles. Abstract of paper read at Dover meeting of the British Assn. Calls attention to the importance electro-metallurgy is taking in engineering works, and describes a few applications. Ill. 3000 w. Elec Rev, Lond—Sept. 22, 1899. Serial, 1st part. No. 30040 A.

ELECTRO-PHYSICS.

Batteries.

A Review of the Development of Primary Galvanic Batteries During the Last 25 Years (Rückblick auf die Entwickelung der Primaren Galvanischen Batterien während der Letzten 25 Jahre). An interesting historical contribution to electrical science. 3000 w. Elektrochemische Zeitschr—Oct., 1899. No. 30482 G.

The Chemical and Contact Theories. W. R. Cooper. From a book on primary batteries to be published shortly by the Elect'n Pub. Co. Considers the investigations of Volts, Kohlrausch, and others. Ill. 2800 w. Elect'n, Lond—Oct. 13, 1899. Serial. 1st part. No. 30330 A.

The Practical Limitations of Dry Batteries. Aims to correct the misleading descriptions given of the capacity and efficiency. 900 w. Elec Rev—Lond—Oct. 13, 1899. No. 30305 A.

The Relation Between Electromotive Force and Chemical Heat in Galvanic Elements (Ueber das Verhältniss Zwischen Elektromotorischer Kraft und Chemischer Wärme in den Galvanischen Elementen). T. Gross. An exhaustive discussion, comparing the results of a number of experimental investigations with the mechanical theory of heat. 5000 w. Elektrochemische Zeitschr—Oct., 1899. No. 30481 G.

Thermal Relations in the Voltaic Cell. W. R. Cooper. From a book soon to be

published by *The Electrician*. Considers the constitution of the cell and discusses mathematically the thermal relations. 4200 w. Elect'n, Lond—Sept. 29, 1899. No. 30121 A.

Electric Waves.

Velocities of Electro-Magnetic Waves in Air and Along Wires. M. C. Gutton. Translation of a paper presented at meeting of the Société Internationale des Electriciens. Reviews discoveries and experiments. 1200 w. Elec Rev, N. Y. Oct. 18, 1899. No. 30245.

Thermoelectricity.

On Thermoelectricity in Certain Metals. Ludwig Holborn and Arthur L. Day. Gives results of investigations. 1300 w. Am Jour of Sci—Oct., 1899. No. 29937 D.

GENERATING STATIONS.

Alternating Generators.

Alternating Generators for Direct Service, Alton D. Adams. An explanation of the desirable features. 1200 w. Elec Wld & Engr—Oct. 7, 1899. No. 30108.

Batteries.

See Mechanical Engineering, Automobilism.

Chicago.

The Double-Current Generators and Polyphase Apparatus of the Chicago Edison Company. Homer E. Niesz. Illustrates and describes a complete equipment for the simultaneous generation of alternating and direct currents in the same machines, or the conversion of direct to alternating currents for high-tension transmission purposes and reconversion. 3500 w. Am Elect'n—Oct., 1899. No. 30113.

Converters.

The Design of Rotary Converters. H. F. Parshall and H. M. Hobart. Part first gives tabulated results of investigations, and introductory remarks to the subject of proper lines on which to design rotary converters. 2000 w. Engng—Sept. 29, 1899. Serial. 1st part. No. 30124 A.

Darwen, Eng.

Darwen Electricity Works. Illustrated description of an English installation. 3500 w. Elec Eng, Lond—Sept. 29, 1899. No. 30123 A.

Dynamos.

Application of the Dynamo. H. Richards, Jr. Considers briefly its connection with the electric railway and lighting purposes. 800 w. Yale Sci M—Oct., 1899. No. 30161 C.

Economies.

Notes on Power-Station Economies. Maurice Hoopes. Gives results of the writer's experience. 1400 w. Elec Rev, N. Y.—Oct. 11, 1899. Serial. 1st part. No. 30168.

Henrichsburg.

Steam Engines and Dynamos at the Heinrichsburg Canal Lift. Brief illustrated description of engines forming a part of the electric generating plant at a lift on the Dortmund-Ems Canal. 500 w. Engr, Lond—Oct. 6, 1899. No. 30230 A.

Isolated Plant.

The Isolated Plant of a Wholesale Grocer's Establishment. An interesting description of the plant of the Garrett Building, Chicago. It includes novel features for solving the problems of a wholesale grocer's business. 3000 w. Am Elect'n—Oct., 1899. No. 30114.

Power Houses.

Chicago Electric Railway Power Houses. Illustrations with brief descriptions. 1600 w. Elec Wld & Engr—Oct. 14, 1899. No. 30502.

Power Plant.

St. Cloud, Minn., Water Power Plant. F. W. Springer. Illustrated description. Gives an ingenious means of maintaining constant voltage. 1600 w. Elec Wld & Engr—Sept. 30, 1899. No. 29949.

Sandwich Islands.

Electrical Plants in the Sandwich Islands. Illustrates and describes the plants of the Hawaiian Elec. Co., Ltd., the Hilo Elec. Lgt. Co., Ltd., and the government plant on the Island of Oahu. 1000 w. Elec Wld & Engr—Oct. 7, 1899. No. 30105.

Snoqualmie Falls.

Snoqualmie Falls Power Plant. Illustrated description of a 10,000 H. P. hydraulic plant with novel features. 2000 w. Power—Oct., 1899. No. 29993.

The Snoqualmie Falls Transmission Plant: An illustrated detailed description. 2500 w. Elec Wld & Engr—Oct. 21, 1899. No. 30274.

Sparking.

Commutation and the Prevention of Sparking. Describes how commutation is effected, and gives methods of preventing sparking. Ill. 1400 w. Engr, U. S. A.—Oct. 1, 1899. No. 30070.

Waste.

Profitable Disposition of the Waste Product of a Power Plant. Considers some of the means of economizing and of utilizing seeming waste. 1800 w. Engr, U. S. A.—Oct. 15, 1899. Serial. 1st part. No. 30242.

Woburn.

Woburn, Mass., New Central Station. L. R. Wallis. Illustrated description of a distinctly modern lighting and power

plant. 1600 w. Elec Wld & Engr—Oct. 28, 1899. No. 30383.

LIGHTING.

Arc Lighting.

Series Arc Lighting from Constant-Current Transformers. William Lispenard Robb. Read before the Am. Inst. of Elec. Engs. Describes the system of the Hartford Electric Light Co. 2500 w. Elec Rev, N. Y.—Oct. 11, 1899. No. 30169.

Artificial Lighting.

Herr W. von Oechelhaeuser on Progress in Artificial Lighting. An epitome of the inaugural address of the President of the German Assn. of Gas and Water Engs. On the recent advances in the lighting industries. 2800 w. Jour Gas Lgt—Sept. 26, 1899. No. 30079 A.

Incandescent Lamps.

Cost of Lighting by Incandescent Street Lamps. Alton D. Adams. Considers the conditions affecting the cost. 1500 w. Munic Engng—Oct., 1899. No. 29984 C.

Incandescent Lamp and Transformer Construction in America. Henry E. P. Cottrell. Discusses the factors that determine the "candleage" of a lamp, and the details of construction upon which the efficiency of the transformers depends. Ill. 3500 w. Engr, Lond—Oct. 13, 1899. Serial. 1st part. No. 30307 A.

Nernst Lamp.

The Forerunners of the Nernst Lamps. Etienne de Fodor. Translated and abridged from *Elektrotechnischer Anzeiger*. Historical review of predecessors. 2000 w. Elec Rev, N. Y.—Sept. 27, 1899. Serial. 1st part. No. 29922.

Search Lights.

See Marine Engineering.

Street Lighting.

Public Electric Lighting. A consideration of the best method and the cost of obtaining satisfactory service from private companies. 900 w. Eng Rec—Oct. 21, 1899. No. 30287.

MEASUREMENT.

Alternating.

The Measurement of Alternating Current Effects by the Three-Voltmeter Method (Zur Messung von Wechselstromeffekten nach der Drei-Voltmeter Methode). F. Niethammer. A mathematical demonstration, showing that the three-voltmeter method is independent of curve form or phase. 3000 w. Elektrotech Zeitschr—Oct. 5, 1899. No. 30476 B.

Converter.

Investigations Upon a Converter (Untersuchungen an Einem Umformer). K. Pichelmayer. Giving the results of a study of a rotary converter, when operated under a variety of conditions. 4500 w. Elektrotech Zeitschr—Oct. 5, 1899. No. 30475 B.

Frequency.

Frequency Measurement. A reprint of a portion of a paper read by W. R. Ayrton and John Perry before the Inst. of Elec. Engs. about ten years ago, considering this subject. 1800 w. Elec Wld & Engr—Oct. 14, 1899. No. 30504.

Losses.

The Separation of the Iron Losses in the Transformation of Alternating Currents (Ueber die Treuming der Eisenverluste bei Wechselstrom transformatoren). W. Peukert. A discussion of the methods of distinguishing between the extent of losses due to eddy currents and hysteresis in transformers. 3000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30468 B.

Methods.

Electrical Measurement. H. E. Wimperis. A statement of the most fundamental facts of how electrical quantities are measured. 1000 w. Automotor Jour—Sept. 15, 1899. No. 30050 A.

Resistances.

Progress in the Construction of Electrical Resistances (Fortschritte im Bau Elektrischer Widerstande). Dr. M. Levy. With numerous illustrations of improved resistance boxes in which strips of metal are used instead of coils of wire. 2000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30469 B.

POWER APPLICATIONS.

Auxiliary.

See Marine Engineering.

Carrier.

Electrically Driven Carrier System (Elektrisch Betriebene Aktentransportbahn). Illustrating a neatly designed carrier for use in business establishments, department stores, post offices, etc. 1000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30470 B.

Cranes.

Electric Travellers. Joseph Horner. Discusses the development and designs of electric travellers in England and America. 3500 w. Mech Wld—Sept. 29, 1899. Serial. 1st part. No. 30119 A.

Electrical Dredges.

American Electrical Dredges on the Volga River, Russia. Illustrated detailed description of these high-powered suction dredges. 3000 w. Elec Wld & Engr—Oct. 7, 1899. No. 30104.

Electric Power.

See Mech. Engineering, Automobilism.
See Mining and Metallurgy, Mining.

Elevator.

A Type of Heavy Electric Sidewalk Elevator. Illustrated detailed description of hoists of the Ivins Syndicate Building of New York city. 700 w. Eng News—Sept. 28, 1899. No. 29958.

Friction.

The Friction Losses of Induction Motors when Unloaded (Ueber die Leerlaufreibung von Induktionsmotoren). R. Braun. A mathematical investigation of the methods of measuring the friction losses when no external work is being done. 2500 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30471 B.

Induction Motors.

The Action of the Polyphase Induction Motor Graphically Explained. An analysis of the interaction of the currents and magnetizations produced. 7000 w. Elec. Wld & Engr—Sept. 30, 1899. No. 29951.

Kearsarge.

See Marine Engineering.

Machine Driving.

Electric Driving in Machine Works and Rolling Mills (Elektrischer Antrieb in Hütten und Walzwerken). O. Lasche. With especial reference to the driving of the mills for rolling copper rod and wire for the *Allgemeine Electricitäts-Gesellschaft* at Berlin. 4500 w. Stahl und Eisen—Oct. 1, 1899. No. 30463 D.

Motive Power.

Small Motive-Power Selection. Alton D. Adams. Discusses the comparative advantages of electric motors, gas engines and steam engines. 1200 w. Am Arch—Oct. 14, 1899. No. 30207.

Motor Control.

See Street and Electric Tramways.

Motors.

See Street and Electric Tramways.

Printing Motors.

The Practical Application of Electric Motors to Printing Press Machinery. W. H. Tapley. Considers what is the best known motor and how it shall be applied. 7000 w. Jour Fr Inst—Oct., 1899. No. 30088 D.

Pumping.

See Mining and Metallurgy, Mining.

Sanitation.

Electricity for Sanitation at Havana. Illustrated description of a plant employing the Woolf electrical process for the production of hypochlorites from sea water. 1100 w. Elec Wld & Engr—Oct. 7, 1899. No. 30107.

Single-Phase Motors.

Some Notes on Single-Phase Motors, with Special Reference to the Heyland Motors. A. C. Eborall. Briefly discusses what takes place in single-phase motors during starting and running, and describes the fundamental principles and construction of the Heyland motors. Ill. 3200 w. Elec Rev, Lond—Sept. 29, 1899. No. 30122 A.

Steel Works.

An American Electric Power Plant at the Frodingham Steel and Iron Works, England. Illustrated detailed description. 7000 w. Jour Fr Inst—Oct., 1899. No. 30088 D.

Electric Power as a Factor in Steel Mills. Some of the appliances for handling the metal in its various stages are illustrated and described. The plant is that of the Illinois Steel Co., at South Chicago. 1600 w. Am Elect'n—Oct., 1899. No. 30115.

TRANSMISSION.

India.

Electricity in India. C. C. Townsend. On the advantages that would follow the development of electricity from natural sources. 1700 w. Nineteenth Cent—Oct., 1899. No. 30270 D.

Kalamazoo.

Kalamazoo Valley, Michigan, Transmission Plant. Edward James Hart. Illustrates and describes the plant and line. 1800 w. Elec Wld & Engr—Sept. 30, 1899. No. 29950.

Long Distance.

Mt. Whitney, Cal., Transmission Plant. Donald H. Fry. Illustrates and describes the interesting features of this hydraulic electric plant. 1800 w. Elec Wld & Engr—Oct. 28, 1899. No. 30384.

Paderno.

The Power Transmission from Paderno to Milan (Die Kraftübertragung von Paderno nach Mailand). Ugo Ancona. With numerous illustrations of the hydraulic and electric generating station, and of the transforming and distributing system. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1899. No. 30442 D.

Power Transmission.

The Kootenay-Rossland Power Transmission. An illustrated description of the sub-station at Rossland, and of the application of the power for mining purposes. 3500 w. Can Elec News—Oct., 1899. No. 30210.

MISCELLANY.

Address.

The Centenary of the Electric Current, 1799-1899. J. A. Fleming. Abstract of a lecture delivered at Dover meeting of the British Assn. A review of the chief conclusions reached after a century of investigation, and a discussion of the problems remaining to be solved in determin-

ing what is an electric current. 5000 w. Elect'n, Lond—Sept. 22, 1899. No. 30036 A.

Animal Electricity.

Animal Electricity. W. S. Hedley. Considers various electrical results of excitation and the theories advanced. 2800 w. Elec Rev, Lond—Sept. 22, 1899. No. 30038 A.

Commutator Tools.

The Construction of Some Handy Commutator Tools. Alton D. Adams. Describes simple and inexpensive tools of great service, and states requirements and methods used. 1800 w. Am Elect'n —Oct., 1899. No. 30117.

Electrographs.

Electrographs of the Electro-Static Current Made Without a Camera. Elmer Gates. Illustrated account of interesting experiments showing the path taken by the current. 1600 w. Sci Am—Oct. 7, 1899. No. 30072.

Smokeless Powder.

Electricity in the Manufacture of Smokeless Powder. Describes the government electrical plant at Indian Head. Ill. 1200 w. Elec Rev, N. Y.—Sept. 27, 1899. No. 29921.

Specifications.

Notes on Electrical Specifications. Ernest Kilburn Scott. Criticism of the usual form of specifications, discussing the various points in detail. 3500 w. Elec Rev, Lond—Oct. 6, 1899. No. 30222 A.

GAS ENGINEERING

GAS ENGINEERING.

Acetylene.

Acetylene Gas Considered from the Firemen's Standpoint. William McDavitt. From an address at Syracuse, N. Y., convention. Describes the dangerous properties of calcium carbide, and the way to extinguish a fire caused by it. 1400 w. San Plumb—Oct. 2, 1899. No. 30061.

Acetylene Gas Lighting at Hawes. Describes a public scheme of lighting by acetylene gas successfully carried out in a small market town. 700 w. Engr, Lond —Oct. 13, 1899. No. 30310 A.

An Acetylene Gas Plant. Describes a municipal plant at Schönsee, Prussia, designed to supply 2000 burners. 900 w. Eng Rec—Oct. 21, 1899. No. 30289.

Progress in the Acetylene Gas Industry. John B. C. Kershaw. Considers the advance made in the generation and purification of acetylene and the progress in its utilization. 2200 w. Elec Rev, Lond —Oct. 6, 1899. No. 30223 A.

The Chloride of Lime Process for the Purification of Acetylene. F. B. Ahrens, in *Zeitschrift für Augewandte Chemie.* Abstract translation. The objectionable behavior of chloride of lime as a purifying agent and the reasons, and its efficiency. 900 w. Jour Gas Lgt—Sept. 19, 1899. No. 29948 A.

The Papers Read at the Acetylene Congress. Abstract translations of more important papers read, as taken from the report of Herr F. Liebetanz. 2700 w. Jour Gas Lgt—Oct. 17, 1899. Serial. 1st part. No. 30359 A.

Address.

President's Address Before the Waverley Association of Gas Managers. W. B. McLusky. A review of the working details of small gasworks, considering carbonizing, coal temperature and purification, and unaccounted for gas. Also discussion. 5400 w. Jour Gas Lgt—Sept. 19, 1899. No. 29947 A.

Blast-Furnace Gases.

Plants for Utilizing Blast-Furnace Gases. H. Savage. Abstract of a paper in the *Revue Universelle des Mines.* Concerning plants in Belgium and Germany. Also editorial. Ill. 2200 w. Eng & Min Jour—Oct. 7, 1899. No. 30081.

Carbonic Acid.

The Manufacture of Liquefied Carbonic Acid. An account of the London Carbonic Acid Gas Works. Ill. 1300 w. Engng—Oct. 20, 1899. No. 30512 A.

Coke-Oven Gases.

The Utilization of Coke-Oven Gases for Lighting. Abstract from *Stahl und Eisen.* Discusses various methods tried and their results, giving suggestions to obtain the best results. 1800 w. Ir & Coal Trds Rev—Sept. 22, 1899. No. 29961 A.

Utilizing Coke-Oven Gases for Motive Power. A. von Ihering, in *Stahl und Eisen.* A comparison of the relative efficiency of motors actuated by blast-furnace gas and coke-oven gases. 1700 w. Col Guard—Sept. 22, 1899. No. 29974 A.

Gas Liquor.

Treatment of Gas Liquor. Abstracts from "The Mineral Industry" article upon Recovery of Ammonia and Ammonium Sulphate from Gas Liquor, by Hans A. Frasch. 1700 w. Pro Age—Oct. 2, 1899. No. 30006.

Gas Plants.

Dimensions of Gas Plant. Ernest J. Sutcliffe. A tabulated statement of various opinions concerning the size of gas plant in proportion to the work required of it. 1800 w. Jour Gas Lgt—Oct. 17, 1899. No. 30358 A.

The 400-H. P. Gas Producer Plant for the Erie Railroad. Illustrates and describes the main features. 1000 w. R R Gaz—Sept. 29, 1899. No. 29941.

Governors.

All Sorts and Conditions of Governors. E. H. Millard. Read before the North of England Gas Managers' Assn. Considers governors used in gas manufacture. 3800 w. Jour Gas Lgt—Oct. 10, 1899. No. 30247 A.

Illumination.

Another View of Interior Illumination. F. N. Morton. Read at meeting of the Am. Gas Lgt. Assn. Discusses indirect lighting, describing experiments and the success attained. 4200 w. Am Gas Lgt Jour—Oct. 23, 1899. No. 30324.

Mantles.

Influence of Cerium in Incandescent Mantles. W. Bruno. Translated from *Zeitschrift für Beleuchtungswesen*. Gives a report of observations and experiments. 1800 w. Pro Age—Oct. 2, 1899. No. 30007.

The "Cerofirm" Mantle. Résumé of communication by W. Bruno in *Zeitschrift für Beleuchtungswesen*. An account of researeches which led to the manufacture of this mantle. 3200 w. Jour Gas Lgt—Oct. 10, 1899. No. 30248 A.

Meters.

Notes on Prepayment Meters. A. H. Strecker. Read before the Am. Gas Lgt. Assn. Gives deductions drawn from experience. 2800 w. Am Gas Lgt Jour—Oct. 30, 1899. No. 30507.

Mixtures.

On Gaseous Mixtures. Translation of notes by A. Leduc and by Paul Sacerdote. An examination of the received law. 1800 w. Jour Fr Inst—Oct., 1899. No. 30090 D.

Naphthalene.

The Quantity of Naphthalene in Gas. William Young. On the value as an illuminant of the naphthalene usually present in coal gas. 1700 w. Jour Gas Lgt—Sept. 26, 1899. No. 30077 A.

Pumping.

The Pumping of Gas. George J. Roberts. Read before the Am. Gas Lgt. Assn. Data to aid the engineer in determining the kind and size of pumping plant needed. 1700 w. Am Gas Lgt Jour—Oct. 30, 1899. No. 30508.

Steam Consumption.

The Steam Consumption in a Water Gas Plant. Alten S. Miller. Read at meeting of the Am. Gas Lgt. Assn. Discusses what can be done to cut down the consumption of steam in gas works. 1800 w. Am Gas Lgt Jour—Oct. 23, 1899. No. 30325.

Tar.

A Commentary on Herr G. Liegel's Paper on Preventing the Thickening of Tar, with a Practical Illustration. Frederic Egner. 1700 w. Am Gas Lgt Jour—Oct. 16, 1899. No. 30213.

Water Gas.

Professor Lunge on the Dellwik Water-Gas Process. Abstract translation of an article in the *Journal für Gasbeleuchtung*. Ill. 3300 w. Jour Gas Lgt—Oct. 3, 1899. No. 30155 A.

The Recent Committee on Carburetted Water Gas. J. Carter. Read at Sleaford, Eng., before the Eastern Counties Gas Mngrs'. Assn. On the work of the commission and its object, with the advantages and disadvantages brought out. Discussion. 11500 w. Jour Gas Lgt—Sept. 26, 1899. No. 30078 A.

MARINE AND NAVAL ENGINEERING

Auxiliary Cruisers.

American Liners as Auxiliary Cruisers in the Spanish-American War. W. G. Randle. A report of the service rendered by the St. Louis. 900 w. Marine Rev—Sept. 28, 1899. No. 30022.

Auxiliary Machinery.

Electrical Machinery on Board Ship. Alexander Siemens. Abstract of paper read before the British Assn. Also editorial. Describes prevailing practice. 3300 w. Engr, Lond—Sept. 22, 1899. No. 29980 A.

Electricity for the Auxiliary Machinery on War Ships. Lieut. J. K. Robison. Showing the need of higher economy at the generating end of the plant before electrical auxiliary machinery can attain its full extension on naval vessels. 3500 w. Engineering Magazine—Nov., 1899. No. 30493 B.

Battleship.

H. M. S. London. A recently launched vessel of a new class, of interest because of her armor system. 500 w. Engr, Lond—Sept. 29, 1899. No. 30137 A.

We supply copies of these articles. See introductory.

Fishing Boats.

The Maritime Fisheries Exposition at Bergen (L'Exposition des Pêches Maritimes à Bergen). M. J. Pérard. With many illustrations of fishing boats and appliances. 20,000 w. Bull de la Soc d'Encour—Sept., 1899. No. 30457 G.

Flag Ship.

Farragut's Old Flag Ship, the Hartford. Illustrated description of this ship, which is to be preserved as a training ship. 900 w. Marine Rev—Sept. 28, 1899. No. 30029.

Germany.

The Development of German Shipbuilding. The climax of Herr Haack's admirable series of papers, summing up the economic and sociological elements of Germany's wonderful industrial growth, as exemplified to the fullest extent in her ship-building. 4000 w. Engineering Magazine—Nov., 1899. No. 30496 B.

Kearsarge.

Electrical Features of the United States Battleship Kearsage. This is the first battleship to be provided with a complete electrical power transmission plant. Also editorial. Ill. 1500 w. Elec Rev, N. Y.—Sept. 27, 1899. No. 29923.

Life Saving.

Organization and Development of the United States Life-Saving Service. An illustrated account of this work from data furnished by Sumner I. Kimball, chief of the service. 3500 w. Marine Rev—Oct. 12, 1899. No. 30209.

Merchant Marine.

Establishment of an American Merchant Marine. Eugene Tyler Chamberlain. Reviews the progress of maritime nations and their methods, commenting on the active interest among Americans. 2000 w. Marine Rev—Sept. 28, 1899. No. 30025.

Naval Designs.

Notes on Our Recent Naval Program and Designs, with Particular Reference to the Influence of the Spanish War. Philip Hichborn. On the effects of the Spanish war on public opinion, and on expert opinion. 3500 w. Marine Rev—Sept. 28, 1899. No. 30021.

Naval Warfare.

The Naval Warfare of the Future. Lawrence Irwell. Discusses various types of vessels used, the present conditions and the dangers of modern seafights. 2500 w. Marine Rev—Oct. 26, 1899. No. 30382.

Oceanic.

Magnificent Decorations and Furnishings of the Oceanic. Interesting views with description. 1500 w. Marine Rev—Oct. 12, 1899. No. 30208.

Windlass and Capstan Gear of R. M. S. "Oceanic." Illustrated description of gear proportioned to work cables of iron 3¼ in. in diameter. 1400 w. Engng—Oct. 6, 1899. No. 30226 A.

Paddle-Wheel.

Early Paddle-Wheel Steamships. Part first illustrates and describes the Hudson River steamers and the steamers of the Fall River Line. 2300 w. Engr, Lond—Oct. 13, 1899. Serial. 1st part. No. 30311 A.

Practice Ship.

Construction and Equipment of the U. S. Naval Academy Practice Ship Chesapeake. Illustrates and describes this vessel, constructed for the use of the cadets for training. 1600 w. Marine Engng—Oct., 1899. No. 30096 C.

Protective Coatings.

Experiments on the Protection of Steel and Aluminum Exposed to Water. A. H. Sabin. A statement of the results of the continuation of a series of experiments to determine the comparative durability of paints and varnishes. 4200 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30349 E.

Range Finding.

Range Finders and Range Finding. Gives an illustrated description of various range finders, explaining their use, especially on board ships. 4400 w. Ir Age—Oct. 5, 1899. No. 30043.

Revenue Cutters.

New Revenue Cutters. Illustrated description and plans of two vessels of the first class, one for coast service and the other for the Great Lakes. 1500 w. Marine Rev—Sept. 28, 1899. No. 30027.

Searchlights.

Method of Operating Searchlights More Efficiently by Use of Dynamotors. Alton D. Adams. On the changed conditions which render it desirable to operate searchlights independent of the voltage of the system from which the power is drawn, and how it is accomplished. Ill. 1800 w. Marine Engng—Oct., 1899. No. 30095 C.

Shipbuilding Plant.

Electric Power in a Ship Yard. Illustrated description of features of the Chicago Shipbuilding Co.'s plant. 2000 w. Am Elect'n—Oct., 1899. No. 30116.

Shipbuilding.

Marine Engineering and Shipbuildng on the Thames. A brief account of the work now in hand. 4200 w. Engr, Lond—Sept. 29, 1899. No. 30135 A.

Shipbuilding Plant of Wolff & Zwicker, at Portland, Me., on Pacific Coast. Brief illustrated description. 800 w. Marine Engng—Oct., 1899. No. 30093 C.

Steamship.

The Cunard Liner "Ivernia." Gives the leading particulars of this new vessel, and compares its size with other large steamships. 18000 w. Engng—Sept. 22, 1899. No. 29967 A.

Stern-Wheel.

Stern Wheel River Steamboat for the Klondike Trade. An illustrated description of the "Willie Irving," a vessel plying on the upper Yukon river. 1200 w. Marine Engng—Oct., 1899. No. 30094 C.

Submarine Boat.

The Lake Submarine Boat. Illustrated description of the "Argonaut," invented by Simon Lake, with a statement of the principal facts claimed to be established. 2000 w. Engr, Lond—Oct. 6, 1899. No. 30231 A.

Testing Tools.

Boats and Sails. Walter Burnham. Part first illustrates and describes tools for testing boat models. 3000 w. Sci Am Sup—Oct. 14, 1899. Serial. 1st part. No. 30172.

Torpedo Boats.

American Torpedo Boats of Recent Construction. Waldon Fawcett. Information concerning the excellence of these boats, especially those constructed on the western seaboard. 2000 w. Mod Mach—Oct., 1899. No. 30062.

Our Torpedo Boat Flotilla. Waldon Fawcett. Discusses the policy of the U. S. navy with regard to torpedo boats, and the achievements of the latest boats. 2200 w. Marine Rev—Sept. 28, 1899. No. 30024.

Transportation.

Taking Steamers by Inland Route to the Caspian Sea. Illustrates the method adopted for taking the twin-screw steamer "Meridian" from St. Petersburg through the Marinski Canal system and down the Volga. 700 w. Engr, Lond—Sept. 22, 1899. No. 29979 A.

Transport Service.

Transport Service of the United States Army. Describes the ships and their equipment and comments on the speedy organization. Ill. 2500 w. Marine Rev—Sept. 28, 1899. No. 30030.

Tug Boats.

Type of Fire Tube Boiler Adapted for Tug-Boat Service. Discusses the poor designs of boilers in use in tugboats, and gives illustrated description of a single-ended Scotch boiler to carry 125 lbs. steam pressure. 800 w. Marine Engng—Oct., 1899. No. 30092 C.

Turbine Steamer.

Fast Cross-Channel Steamer. C. H. Parsons. Read before the British Assn., at Dover meeting. Describes a proposed 30-knot turbine boat, stating its advantages. 1200 w. Engng—Sept. 22, 1899. No. 29968 A.

U. S. Coast Survey.

The United States Coast and Geodetic Survey. Herbert C. Graves. A brief review of the history of this work, its systems and importance, with information relating to it. Ill. 3800 w. Marine Rev—Oct. 5, 1899. No. 30080.

Valve Gear.

Long Radial Valve Gear. Lincoln A. Lang. Illustrates and describes a new gear that has been applied to several small steam vessels on the Great Lakes. 2200 w. Marine Rev—Oct. 19, 1899. No. 30298.

Yacht Racing.

Fifty Years of International Yacht Racing. A review of the history of these races, with illustrations and descriptions of yachts. 2500 w. Sci Am—Oct. 7, 1899. Serial. 1st part. No. 30073.

Yachts.

Consideration of the Steam Yacht from the Designer's Point of View. William A. Fairburn. Interesting descriptions of famous yachts, classifying them in five groups. 2700 w. Marine Engng—Oct., 1899. Serial. 1st part. No. 30091 C.

The Steam Yacht "Josephine." Illustrated description of a beautiful yacht built for P. A. B. Widener, of Philadelphia. 1500 w. Sci Am Sup—Oct. 7, 1899. No. 30074.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Aluminum.

The Possibilities and Uses of Aluminum as Applied to Carriage Building. Percy W. Northey. Read before the Inst. of British Carriage Builders. Presents advantages justifying the use of this metal and the economy in manufacture effected. 1600 w. Automotor Jour—Oct., 1899. No. 30363 A.

Balancing.

Balancing of Motors. H. E. Wimperis. Considers points most important in connection with balancing motors and reducing vibration. 900 w. Automotor Jour—Oct., 1899. Serial. 1st part. No. 30365 A.

Batteries.

The Charging and Care of Automobile Batteries. Theodore D. Bunce, in the *Horseless Age*. An explanation of the general features of the battery, and the care needed. 1800 w. Sci Am Sup—Oct. 14, 1899. No. 30173.

Club.

The Automobile Club of France. Baudry de Saunier. Illustrations of the Club House and history of the society. 2000 w. Auto Mag—Oct., 1899. No. 29933 C.

The Automobile Club of France. Francis P. Mann. History of the organization. 2500 w. Sci Am Sup—Sept. 30, 1899. No. 29930.

Competitions.

The Competition of Heavy Weights, 1898, and the Second Competition of Automobile Cabs, 1899 (Concours des Poids Lourds de 1898, et le Deuxième Concours de Fiacres Automobiles en 1899). M. G. Forestier. A review of the reports and a general discussion of the automobile situation. 9000 w. Mem de la Soc Ing Civ de France—Aug., 1899. No. 30464 G.

Detachable Motor.

A Missing Link Vehicle. Illustrates a detachable motor that may be substituted for the front wheels of any vehicle and so convert it into an automobile. 1600 w. Auto Mag—Oct., 1899. No. 29935 C.

Early History.

The Genesis of the Automobile. John Grand Carteret. Review of progress since the 17th century, giving illustrations. 2000 w. Auto Mag—Oct., 1899. No. 29934 C.

Electric Power.

Electrically Driven Automobiles. (Ueber Elektrisch Betriebene Selbst fahrer). C. P. Feldmann. A review of the electrically driven vehicles shown at the recent Paris competitions. 2500 w. Elektrotech Zeitschr—Oct. 5, 1899. No. 30477 B.

Electric Cabs in Chicago. Illustrates and describes the vehicles of the Illinois Electric Vehicle Transportation Co., giving related information. 2500 w. W Elect'n—Oct. 7, 1899. No. 30112.

Exposition.

The International Motor-Carriage Exposition at Berlin. An account of the opening of this exposition, with illustrated description of some of the vehicles. 2500 w. U. S. Cons Repts, No. 561—Oct. 24, 1899. No. 30336 D.

Gears.

Speed-Changing Gears for Motocycles and Phaetons. Ilustrates and describes several speed-changing mechanisms, showing the necessity for their use with the gasoline motor. 1200 w. Sci Am Sup—Oct. 14, 1899. No. 30171.

Heavy Weights.

Heavy Motor Car Trials in France. Comments on features of interest at the trials held at Versailles. 1600 w. Engr, Lond—Oct. 20, 1899. No. 30514 A.

Henriod System.

The Henriod System of Automobiles. Illustrates and describes the mechanical part of these carriages. 1400 w. Automotor Jour—Sept. 15, 1899. No. 30052 A.

Kerosene Motor.

Secor's Kerosene Burning Motor. Hugh Dolnar. Illustrated description with comments. 1800 w. Am Mach—Oct. 5, 1899. No. 30054.

Some Inaccuracies Corrected. J. D. Lynn. A criticism of statements made by Hugh Dolnar in an article published in the *American Machinist*. 700 w. Am Mfr & Ir Wld—Oct. 19, 1899. No. 30271.

Liquid Fuel.

The Musker Automatic Liquid Fuel Burner. Illustrated description of an apparatus designed for motor vehicles. 1800 w. Automotor Jour—Sept. 15, 1899. No. 30053 A.

Motor Omnibus.

The Siemens & Halske Electric Street-Omnibus (Der Elektrische Strassenbahn-Omnibus der Siemens & Halske A. G.). H. Siebert. Illustrating and describing a vehicle for general street service, using both overhead wire and accumulators, with details of motors and controller. 3000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30467 B.

Motor Sprinkler.

An Automobile Street Sweeper and Sprinkler. From *La Nature*. Gives illustrations and particulars of an apparatus which has given very satisfactory results in Paris. 500 w. Sci Am Sup—Oct. 7, 1899. No. 30075.

Motor Vehicles.

Horseless Carriages. George N. Crouse. Brief review of progress in France, England and the United States. 1800 w. Yale Sci M—Oct., 1899. No. 30159 C.

Newport Parade.

Newport in the Lead. Edwin Emerson, Jr. An illustrated description of the vehicles. 2800 w. Auto Mag—Oct., 1899. No. 29932 C.

Plateway.

A Motor Plateway between Liverpool and Manchester. An explanation of Dibbin's scheme, giving a section of road. 1700 w. Automotor Jour—Sept. 15, 1899. No. 30051 A.

Steam Lurry.

The Simpson and Bodman Steam

Lurry. An illustrated detailed description of vehicles of new design, the generator, and tests made. 4000 w. Automotor Jour—Oct., 1899. No. 30364 A.

Steam Wagons.

Recent Experiences with Steam on Common Roads. John J. Thornycroft. Remarks on the importance of building durable vehicles and on tare weight, with brief description of vehicles built to the writer's designs. Ill. 5500 w. Engng—Sept. 22, 1899. No. 29964 A.

Ventilation.

The Removal of Odors from Electric Battery Vehicles (Geruchbeseitigung in Akkumulatorwagen). R. Ulbricht. Describing methods of ventilating the batteries of electrical vehicles so as to prevent unpleasant odors. 800 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30473 B.

HYDRAULICS.

Hydraulic Machinery.

Some Notes on the Manufacture of Hydraulic Machinery, Gathered in the Shops of the Watson-Stillman Co. Illustrated description. 2000 w. Mach, N. Y.—Oct., 1899. No. 30017.

Niagara.

Power Development at Niagara Falls Other Than That of the Niagara Power Co. W. C. Johnson. Considers early developments, dating back to 1725. 5500 w. Jour Am of Engng Socs—Aug., 1899. No. 29917 C.

Pumping.

See Mining and Metallurgy, Mining.

Snoqualmie Falls.

See Electrical Engineering, Generating Stations.

Turbines.

The Turbines of the Hydraulic Power Plant at Rheinfelden (Die Turbinen der Kraftübertragungswerke Rheinfelden). F. Prásil. With details of construction and description of the regulating apparatus. 2500 w. Schweizerische Bauzeitung—Oct. 7, 1899. No. 30433 B.

MACHINE WORKS AND FOUNDRIES

Ball Bearings.

A Theoretical Study of Ball Bearings (Etude Théorique sur un Roulement à Billes). Prince Gagarine. A mathematical examination of the action of the ball bearings in the Stokes anemometer, but valuable also as a general discussion of the subject. 1500 w. Génie Civil—Oct. 7, 1899. No. 30408 D.

Brass Furnaces.

The Construction of Brass Melting Furnaces. From a paper by E. Millett, read before the Am. Foundrymen's Assn. Illustrated description. 800 w. Am Mach—Oct. 26, 1899. No. 30357.

Car Coating.

Report of Special Committee on Protective Coating for Iron and Steel Cars. Papers by A. P. Dane and J. L. Johnson. Read at convention of Master Car and Locomotive Painters' Assn., at Philadelphia. Report and discussion. 9300 w. R R Car Jour—Oct., 1899. No. 30076.

Castings.

Casting a Cylinder in Dry Sand. R. H. Palmer. Illustrated detailed description. 3000 w. Am Mach—Oct. 26, 1899. No. 30354.

Malleable Castings. Considers early and recent methods employed. 1800 w. Foundry—Oct., 1899. No. 30244.

Manufacture of the Cast Steel Voussoirs for the Alexander III. Bridge, Paris. Describes the foundry methods adopted, illustrating the principal details. 2400 w. Eng News—Oct. 19, 1899. No. 30257.

Competition.

American Competition. E. A. Stevens. Discusses the material, labor and management of American works as compared with English. 2800 w. Engng—Sept. 22, 1899.. Serial. 1st part. No. 29962 A.

Crane Cheeks.

Machining Crane Cheeks. Joseph Horner. Illustrates and describes English practice in crane building. 1500 w. Am Mach—Oct. 5, 1899. No. 30056.

Crane Girders.

The Machining of Crane Girders. Joseph Horner. Illustrations of the machining of cross girders of cranes by the aid of templets. 1200 w. Am Mach—Oct. 26, 1899. No. 30355.

Drill.

Double Radial Drill-Press (Doppelte Auslegerbohrmaschine). A special tool for drilling the field rings of large electric generators. The drills are electrically driven, and full details are shown. 1500 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1899. No. 30428 D.

Dies.

A Compound Punching and Forming Die. W. E. Willis. Illustrated detailed description, with information relating to the working. 1300 w. Am Mach—Oct. 5, 1899. No. 30055.

Fly-Wheels.

Fly-Wheel Designing. C. H. Benjamin. Practical suggestions, with an explanation of the necessary calculations. Ill. 3000 w. Mach, N. Y.—Oct., 1899. No. 30019.

Forgings.

Making Heavy Steel Forgings. Illustrated description of the plant and prod-

ucts of the Bethelehem Steel Co. 3500 w. Mach, N. Y.—Oct., 1899. No. 30015.

Iron Founding.

Modern Iron Founding. C. W. B. Discusses the evils needing attention. Ill. 1800 w. Mech Wld—Sept. 22, 1899. Serial. 1st part. No. 30041 A.

Jacquard.

A New Method of Making Jacquard Cards by Photography (Nouveau Procédé pour la Mise en Carte des Lissus Jacquard au Moyen de la Photographie). A description of the Szczepanik process. The design is photographed through a perforated screen. 2500 w. Génie Civil —Sept. 30, 1899. No. 30405 D.

Joints.

Toggle-Joints. An illustrated explanation of their principles of operation. 1500 w. Mach, N. Y.—Oct., 1899. No. 30018.

Keys.

Standard Keys. Henry Hess. Gives proportions for straight and taper keys, with derivation of the formulas. 1000 w. Mach, N. Y.—Oct., 1899. No. 30016.

Lathe.

Vertical Cross Turret Lathe. Illustrated description of a fine English machine tool. 1700 w. Engr, Lond—Oct. 6, 1899. No. 30233 A.

Machinery.

Defects in Machinery. Editorial on facts given in report of Mr. Longridge to the Engine, Boiler, and Employers' Liability Insurance Co., Limited, concerning the engine and machine details which give most trouble from failure. 1400 w. Engng—Sept. 29, 1899. No. 30125 A.

Machine Works.

A Modern Machine Works (Eine Moderne Maschinen fabrik). A description of the new works of Ludwig Loewe & Co., in Berlin, with many illustrations. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, 1899. No. 30430 D.

Malleable Casting.

Malleable Furnace Practice and Annealing. Notes on the prevailing practice in malleable work. 3800 w. Ir Trd Rev —Sept. 28, 1899. No. 30014.

Molding.

Molding a Bull Ring. R. H. Palmer. Illustrates and describes the work. 2400 w. Am Mach—Sept. 28, 1899. No. 29926.

Patterns.

A System of Pattern Keeping. G. H. Hall. Describes a system applicable to small shops. 1000 w. Mach, N. Y.—Oct., 1899. No. 30020.

Polishing.

Polishing Machinery (Du Polissage). With many illustrations of general and special devices and an account of their operation. 3500 w. Revue Technique—Sept. 10, 1899. No. 30410 D.

Production.

A Comparison of Hand and Machine Production. Editorial on results of the investigation by the U. S. Dept. of Labor, relating to the relative productive power of hand and machine labor. 1500 w. Eng News—Oct. 5, 1899. No. 30064.

Shells.

Computing the Diameters of Blanks for Cylindrical Shells. George B. Painter. Illustrations and calculations. 1000 w. Am Mach—Sept. 28, 1899. No. 29929.

Shop Practice.

The Revolution in Machine Shop Practice. Henry Roland. Covering the period of the development of the automatic screw machine and tracing the cumulative work of Maudslay, Stone and Spencer in perfecting machine tools for rapid, accurate and economical production. 4000 w. Engineering Magazine—Nov., 1899. No. 30491 B.

Shops.

Maschinenfabrik Oerlikon. Detailed description. 2500 w. Engng—Oct. 20, 1899. No. 30510 A.

Some Considerations Affecting the Location and Design of Machine Shops. Concerning the new shops of the Lane & Bodley Co., of Cincinnati, Ohio. 1500 w. Am Mach—Sept. 28, 1899. No. 29924.

The New Work Shops of Ludw. Loewe & Co., in Berlin. Historical and descriptive account. Ill. 2200 w. Am Mach—Sept. 28, 1899. Serial. 1st part. No. 29925.

The Urbana, O., Shops. Description, with plan, of Cleveland, Cincinnati, Chicago and St. Louis railway repair shops. 1000 w. Loc Engng—Oct., 1899. No. 30002 C.

Standardizing.

Standardizing in Engineering Construction. Sir Benjamin C. Browne. The second paper shows that in specialization lies not only the highest economy and surest industrial success, but the keenest stimulus to the mind and faculties of the workman. 3500 w. Engineering Magazine—Nov., 1899. No. 30490 B.

U. S. Ordnance.

United States Ordnance Factory, from Data Furnished by the Bureau of Ordnance. Illustrated description of the manufacture of big guns. 2000 w. Marine Rev—Sept. 28, 1899. No. 30023.

Works Management.

Works Management for the Maximum of Production. J. Slater Lewis. A thorough study of the problems of so organizing, managing and remunerating la-

bor as to gain the highest efficiency while preserving content and inspiring continued effort among the workers. 3500 w. Engineering Magazine—Nov., 1899. No. 30492 B.

MATERIALS OF CONSTRUCTION.

Coatings.

Coating Cast-Iron Pipes. Thomas H. Wiggin. Describes coal-tar coating. 3000 w. Gas Engs' Mag—Oct. 10, 1899. No. 30346 A.

Elasticity.

The Elastic Equilibrium of a Rectangular Plate (Sur l'Equilibre Elastique d'une Plaque Rectangulaire). Maurice Levy. A mathematical treatment, deducing fundamental equations for various conditions. 1200 w. Comptes Rendus—Oct. 9, 1899. No. 30438 D.

Hose.

Tests of Rubber Hose for Steam Connections on Railway Cars (Prüfung von Gummischläuchen für Dampfheizungs Kupplungen). M. Rudeloff. A valuable report upon tests made for the German State Railway, with full table of results. 3000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part III., 1899. No. 30459 G.

India-Rubber.

The Action of Heat on India-Rubber. Editorial discussion of practical points relating to this subject, about which little is known and much that is misleading has been published. 2500 w. Engng—Oct. 13, 1899. No. 30320 A.

Metals.

The Crystalline Structure of Metals. J. A. Ewing and W. Rosenhain. Abstract of Bakerian Lecture read before the Royal Soc. On the effects of strain and the relation of plasticity to crystalline structure. 2400 w. Engng—Oct. 13, 1899. No. 30321 A.

Microscopy.

Microphotographic Methods (Ueber die Miktophotographie). A. Martens and E. Heyn. A description of the apparatus and methods used in photographing microscopic views of materials at the Government Testing Laboratory at Charlottenburg. 6000 w. 2 plates. Mitt aus den Kgl Tech Versuchsanstalt—Part III., 1899. No. 30458 G.

Screws.

Holding Power of Wood Screws. W. M. Macphail. Read before the Canadian Soc. of Civ. Engs. Gives a record of tests made to determine the relation between the strength developed and the size of the screw when driven in different sized holes in different woods, both parallel to and across the grain. Ill. 1800 w. Engng—Oct. 6, 1899. No. 30227 A.

POWER AND TRANSMISSION.

Compressed Air.

Conveyance of Compressed Air in Pipes. Robert Peele. Concerning the principles governing the losses, and the effects of size of pipes upon transmission losses. 2200 w. Mines & Min—Oct., 1899. No. 30152 C.

Report on Trials Made at Magog, Quebec, to Test the Economy Effected by Reheating Compressed Air. J. T. Nicolson. 1800 w. Compressed Air—Oct., 1899. No. 30118.

See Street and Electric Tramways.

Elevators.

A New Pneumatic Safety Device for High-Speed Passenger Elevators. Illustrates and describes a device designed to combine the immediate action of the clutch device and the gradual action of the air cushion. 1400 w. Eng News—Oct. 19, 1899. No. 30261.

Motive Power.

The Demands of Electro Technics Upon Prime Movers (Anforderungen der Elektrotechnik an die Kraftmaschinen). R. M. Friese. A discussion of the requirements of prime movers for electrical plants, with especial reference to governing. The question of connecting generators in parallel is considered. 7000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, 1899. No. 30429 D.

Pneumatic Despatch.

The Pneumatic Despatch. Gives the leading features, construction and otherwise of a pneumatic despatch constructed under ground in the very heart of London, nearly forty years ago. 1700 w. Engr, Lond—Oct. 13, 1899. No. 30309 A.

Power Generation.

Power Generation—Comparative Cost by the Steam Engine, Water Turbine and Gas Engine. John B. C. Kershaw. Abstract of paper read before Section G of the British Assn. The writer has collected and arranged in comparable form some of the more important data bearing on the cost of power generation. 2500 w. Engr, Lond—Sept. 29, 1899. Serial. 1st part. No. 30138 A.

Speeds.

Stepped Pulleys and Back Gears. Dexter S. Kimball. Describes mechanisms useful in obtaining all speeds in the running of machines. 1800 w. Sib Jour of Engng—Oct., 1899. No. 30341 C.

Wire Tramways.

Wire Tramways. W. R. Shaw. States some of the advantages, the cost of construction, uses, etc., and gives details of tramways now working in various parts of the world. 2200 w. Ind & East Engr

—Sept., 1899. Serial. 1st part. No. 30-300 D.

SPECIAL MOTORS.

Gas Engine.

The Westinghouse Gas Engine. Illustrated description of the novel features of a type of gas engine built in sizes up to 1500 H. P. 1600 w. Eng Rec—Oct. 21, 1899. No. 30286.

Gasoline Engines.

The Gasoline Engine in Boats. Herbert L. Towle. A comparison of the engine power in steam and gasoline launches, with discussion of speed, etc. Ill. 1800 w. Am Mach—Oct. 12, 1899. Serial. 1st part. No. 30165.

Kerosene Motor.

See Mechanical Engineering, Automobilism.

Oil Engines.

Judges' Report of the Trial of Oil Engines at the Edinburgh Show, 1899. Gives the conditions of trials made by the Highland and Agricultural Soc. of Scotland, with description and results. 2000 w. Engr, Lond—Oct. 13, 1899. No. 30513 A.

The Oil Engine. Editorial review of the results of the trials at Edinburgh, by the Highland and Agricultural Soc. of Scotland. 1600 w. Engr, Lond—Oct. 20, 1899. No. 30516 A.

See Mining and Metallurgy, Mining.

Petroleum.

Some Disadvantages of Petroleum as a Motive Power. A statement of difficulties met in the use of this fuel as a motive power, and the efficiency obtained. 1700 w. Col Guard—Oct. 13, 1899. No. 30317 A.

STEAM ENGINEERING.

America.

American Engines and Power Plants (Amerikanische Maschinen und Maschinenanlagen). C. Regenbogen. The first of a series of articles based upon a recent tour in the United States. This instalment is devoted to the pumping machinery of the Cambridge waterworks. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1899. No. 30425 D.

Boiler Compounds.

The Use of Boiler Compounds. W. H. Wakeman. Showing that some compounds injure valve seats and disks and cause other troubles. 1100 w. Am Mach—Oct. 26, 1899. No. 30356.

Boiler Inspection.

Inspection of Boilers by Engineers in Charge. W. J. Ranton. On the importance of a personal inspection by the engineer in charge. 1800 w. Power—Oct., 1899. No. 29994.

Boiler Tests.

Comparison of Boiler Tests. Explains facts that will assist in reducing different reports of tests to a common basis. 1300 w. Col Guard—Sept. 29, 1899. No. 30-133 A.

The Need of Testing Boilers. Report by a committee of the Engineers' Society of Western Pennsylvania. 1000 w. Eng Rec—Oct. 21, 1899. No. 30288.

Chimneys.

Chimneys. H. H. Kelley. The effect of height and area of the chimney on draft is considered, also form, fuel, etc. 3000 w. Engr, U. S. A.—Oct. 1, 1899. No. 30069.

Circulation.

A Study of the Circulation of Water in Multitubular Boilers (Etude de la Circulation de l'Eau dans les Chaudières Multitubulaires). The beginning of the third section of M. Brillié's elaborate study, devoted to the application of the theoretical principles already deduced. A number of the leading types of water-tube boilers are discussed. Serial, 2000 w. Génie Civil—Sept. 23, 1899. No. 30-403 D.

Experiments on the Circulation of Water in Boiler Tubes. M. C. H. Bellens. Experiments made to determine the influence of the diameter of the tubes upon the circulation of water. 1800 w. Power—Oct., 1899. No. 29995.

Condensers.

The Inertia Effect in Condensers (Beharrungsvermögen von Kondensatoren). F. J. Weiss. An exhaustive discussion of the action of central condensers for steam power plants in maintaining a uniform vacuum with variable steam discharges. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1899. No. 30426 D.

Crank-Shafts.

The Stresses in Crank-Shafts. Presents two indicator diagrams and the circumstances under which they were taken, discussing the indications. 1400 w. Elec Rev, Lond—Oct. 13, 1899. No. 30304 A.

Dust Fuel.

The Freitag Apparatus for Coaldust Fuel. L. Kaufmann, in *Zeitschrift des Vereines Deutscher Ingenieure.* Illustrated description of an improved system of automatic stoking with pulverized coal. 1400 w. Coal Guard—Sept. 22, 1899. No. 29972 A.

Explosion.

Boiler Explosion in a Tramway Power House. Describes an explosion apparently due to the gradual deterioration of the plate, at the point of initial fracture from exposure of the joint to the heat of

the furnace. Ill. 800 w. Locomotive—Sept., 1899. No. 30153.

Flow.

The Efflux of Gases and Steam under Diminishing Pressure and Volume (Ueber den Ausfluss von Gasen und Dampfen bei Abnehmendem Druck und bei Abnehmendem Volumen). Dr. Weyrauch. A thorough mathematical treatment of the subject of the efflux of gases, as applied to the work of the engineer. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 30, 1899. No. 30427 each D.

Fuel Economy.

The Fuel Economy of Engines in Electric Railway Power Stations. R. C. Carpenter. Read at meeting of the N. Y. Street Ry. Assn. Gives results of 35 tests of electric railway power stations made during the past eight years by trained students of Cornell Univ., under the supervision of the writer. 2800 w. Eng News—Oct. 12, 1899. No. 30179.

Governors.

Experiments Upon the Action of Engine Governors. William George Hibbins. Read at Inst. of Civ. Engs., England. An account of experiments upon nine types of governors, made at Mason College, Birmingham, Eng. Ill. 1500 w. Am Mfr & Ir Wld—Oct. 12, 1899. Serial. 1st part. No. 30167.

Injectors.

Apparatus for Testing Injectors. Charles Francis Park. Illustrates and describes the apparatus which has been designed and placed in the engineering laboratories of the Mass. Inst. of Technology. 3000 w. Tech Q.—Sept., 1899. No. 30345 E.

Reversing Engines.

Reversing Engines for Rolling Mills (Ueber Reversirmaschinen für Walzwerke). L. Ehrhardt. With numerous indicator diagrams, and plans of vertical, three-cylinder, reversing rolling-mill engine. 4000 w. 1 plate. Stahl und Eisen—Sept. 15, 1899. No. 30461 D.

Smoke.

Smoke Abatement. E. A. Brayley Hodgetts. From a paper read at San. Inst. Cong. On the danger to public health and the means of prevention. 4500 w. Br Arch—Sept. 22, 1899. No. 29944 A.

Smoke Prevention. R. H. Hawkins. Remarks on the necessity of getting the combustion as nearly perfect as possible, the importance of careful stoking, and on mechanical stokers. 1200 w. Yale Sci M—Oct., 1899. No. 30160 C.

Valves.

Safety Valves. H. Highet. An examination of various types. Ill. 1600 w. Prac Engr—Oct. 6, 1899. Serial. 1st part. No. 30220 A.

Water-Tubes.

A Novel Boiler-Tube Extractor. Charles J. Mason. A simple device is illustrated for overcoming a troublesome difficulty which often arises in repairing water-tube boilers. 800 w. Mines & Min—Oct., 1899. No. 30143 C.

The Morrin "Climax" Water-Tube Steam Boiler. Description with illustrations. 600 w. Engr, Lond—Sept. 29, 1899. No. 30140 A.

The Niclausse Water-Tube Boiler. Mark Robinson. Read before the British Assn. Refers briefly to the four types of water-tube boilers already in use, and describes new one named. 4200 w. Engr, Lond—Sept. 22, 1899. No. 29981 A.

MISCELLANY.

Aeronautics.

Practical Means for the Conquest of the Atmosphere (Moyens Actuels de la Conquête de l'Atmosphere). Leo Dex. A discussion of the free and captive balloon, including proposed methods of guiding, the aeroplane, the parachute, and the hélicoptère, from the standpoint of the mechanical principles involved. Two articles, 4500 w. Revue Technique—Sept. 25, Oct. 10, 1899. No. 30412, each D.

Copying.

Copying and Duplication Processes for Technical Use (Praktische Erfahrungen über das Copir-und Vervielfältigungsverfahren in der Technik und in den Gewerben). Dr. T. Koller. Giving details of various blue and black print processes for reproducing mechanical drawings, etc. Two articles, 5000 w. Glaser's Annalen—Sept. 15, Oct. 1, 1899. No. 30440 each D.

Humidity.

Reducing Atmospheric Humidity. Frank Richards. A correspondence giving information on this subject. 1700 w. Am Mach—Sept. 28, 1899. No. 29928.

Invention.

Contributions to the History of Inventions at the Commencement of the Nineteenth Century (Beiträge zur Geschichte der Erfindungen am Beginne des Neunzehnten Jahrhunderts). M. Geitel. A general review of the early inventive work in the present century, from the first German patent law of 1815. Two articles, 6000 w. Glaser's Annalen—Sept. 15, Oct. 1, 1899. No. 30439 each D.

Liquid Air.

Liquefied Gases. Robert M. Chamberlin. Reviews briefly what has been accomplished in this field. Ill. 1800 w. Yale Sci M—Oct., 1899. No. 30163 C.

MINING AND METALLURGY

COAL AND COKE.

Accounts.

A Colliery Audit. George Johnson. An outline of an auditor's duty. 1700 w. Col Guard—Oct. 6, 1899. No. 30238 A.

Analysis.

The Analysis of Coal by Roentgen Rays. Radiographs with description of apparatus used. 1500 w. Ir & Coal Trds Rev—Oct. 13, 1899. No. 30335 A.

The Application of Röntgen Rays for the Determination of Ash in Fossil Minerals (Ueber die Anwendbarkeit der Röntgen Strahlen zur Ermittelung des Aschengehalte Fossiler Mineralien). With reproductions of photographs showing the manner in which siliceous matter contained in coal is revealed. 1500 w. 1 plate. Glückauf—Sept. 16, 1899. No. 30453 B.

Brown-Coal.

Brown-Coal Mining in Bohemia. Part first gives the history of the development. 1200 w. Col Guard—Sept. 22, 1899. Serial. 1st part. No. 29969 A.

Carboniferous Rocks.

Life-Zones in the British Carboniferous Rocks. Report of the committee of the British Assn. Reports on carboniferous rocks and fossils from various districts. 2000 w. Col Guard—Oct. 13, 1899. No. 30318 A.

Coal Fields.

An Illinois Coal Field. A. Dinsmore. Particulars in regard to the formation of the country, a history of the development of the mines, and a description of the methods of working them. 3500 w. Mines & Min—Oct., 1899. No. 30144 C.

Grand River Coal Field of Colorado. Arthur Lakes. A description of the geological phenomena found and their effects upon the coal. Ill. 2700 w. Mines & Min—Oct., 1899. No. 30146 C.

The Coalton Coal Field. Andrew Roy. Description of an interesting Kentucky coal field and its development. 600 w. Mines & Min—Oct., 1899. No. 30148 C.

The South-Eastern Coal-Field. Papers by R. Etheridge, and Prof. Boyd-Dawkins, read at Dover meeting of the British Assn. The first dealt with the relation between the Dover and the Franco-Belgian basins; the second discussed the value of this field. Abstracts. 1500 w. Col Guard—Sept. 22, 1899. No. 29971 A.

Coal Plants.

Possible New Coal Plants in Coal. W. S. Gresley. An illustrated description of evidence obtained in studying coal, mostly anthracite. 2000 w. Am Geol—Oct., 1899. No. 30268 D.

Coking.

The Yield of Coal in Coking. Duncan Anderson, Jr. Considers the yield and character of coke as obtained from the beehive oven, retort oven, and platinum crucible respectively. 1400 w. Ir Age—Sept. 28, 1899. No. 29920.

Coke Oven.

The Bauer By-Product Coke Oven. From *Stahl und Eisen.* Illustrated description of a new form of retort coke oven. 1600 w. Am Mfr & Ir Wld—Sept. 28, 1899. No. 29998.

Coke Oven Gases.

See Gas Engineering.

Colliery Guaranty.

The Interpretation of a Colliery Guaranty. Gives the text of a common form of colliery guaranty with the various clauses numbered and explained by references to points which have been decided in the courts. 4400 w. Col Guard—Sept. 29, 1899. No. 30134 A.

India.

The Coal and Iron Making Resources of India. From the report of R. H. Mahon. Deals with coal and coal fields, giving sketch maps of the chief mineral districts. 4200 w. Ir & Coal Trds Rev—Oct. 13, 1899. Serial. 1st part. No. 30334 A.

Machine Mining.

Improvements in Coal-Cutting Machinery. Illustrates and describes a new tunnelling and ending machine especially useful for rapidly opening new mines. 1200 w. Col Guard—Oct. 6, 1899. No. 30235 A.

Machine Mining at Lethbridge, N. W. T. W. D. L. Hardie. Read before the Min. Inst. of Scotland. Describes this coal field and the work and cost of mining with the Sergeant coal-cutting machines. 3500 w. Can Min Rev—Sept. 30, 1899. No. 30033 B.

New Zealand.

Coal Mining in New Zealand. Harrison F. Bulman. Illustrates and describes the property of the Westport Coal Co., Ltd., the method of working, haulage, etc. 3000 w. Col Guard—Sept. 29, 1899. No. 30127 A.

Pay Bills.

A Colliery Pay. George Johnson. Describes the principal sections of labor included, the form of the bill, etc. 3000 w. Col Guard—Sept. 29, 1899. No. 30129 A.

Records.

Stope Books. Joseph Barrell. A description of the most suitable form of book and illustrations of the manner of recording the variations due to the various methods of working and timbering. 5500 w. Mines & Min—Oct., 1899. No. 30141 C.

Screening Plant.

The New Screening Plant at the Witkowitz Colliery (Dombrau). A. Fillunger, in *Oesterreichische Zeitschrift für Berg-und Huttenwesen.* Illustrated description. 1200 w. Col Guard—Oct. 13, 1899. No. 30315 A.

Spontaneous Combustion.

Method of Ascertaining Whether a Coal May Be Safely Stocked or Shipped. From an article by O. Lang, in *Glückauf.* Extracts and conclusions from a work of Prof. Fischer, of Göttingen. 1500 w. Col Guard—Oct. 13, 1899. No. 30314 A.

Statistics.

The Output, Value and Distribution of Coal During 1898. From the official report of the United Kingdom. 2400 w. Col Guard—Oct. 20, 1899. No. 30520 A.

Testing Plant.

Coaldust Testing Station at the Maria Colliery, Rhenish Prussia. From a communication by Bergassessor Sarter, to *Glückauf.* Descriptive. 1400 w. Col Guard—Sept. 22, 1899. No. 29970 A.

Victoria.

The Coalfields of Victoria. An account of the deposits and recent discoveries. 1300 w. Col Guard—Oct. 6, 1899. No. 30239 A.

Washington Mines.

Coal Mines of Washington. A description of the various mines and an account of their development and prospects. 1600 w. Mines & Min—Oct., 1899. No. 30150 C.

COPPER.

Arizona.

The Copper Queen Mine, Arizona. James Douglas. Condensed from Trans. Am. Inst. of Min. Engs. An account of the mine and its development. Ill. 5000 w. Min & Sci Pr—Oct. 14, 1899. Serial. 1st part. No. 30246.

Idaho.

A New Resource of Copper and Gold. Robert Norman Bell. Letter concerning a new district of rich promise in Eastern Idaho. 2700 w. Mines & Min—Oct., 1899. No. 30147 C.

Roasting Ore.

Roasting Copper Ore at Keswick, Cal. Thomas Neilson. Describes the system of heap roasting, the building of the heap, time required, etc. 2000 w. Eng & Min Jour—Oct. 14, 1899. No. 30217.

Queensland.

Queensland Copper Fields. Information concerning the development and progress. 800 w. Aust Min Stand—Aug. 31, 1899. No. 30157 B.

GOLD AND SILVER.

British Columbia.

Mining in the Boundary District, B. C. Brief description of various mines. Ill. 1200 w. Min & Sci Pr—Sept. 23, 1899. No. 29954.

California.

The Gold Deposits of Nevada County, California. G. P. Grimsley. An account of this district based on a recent visit. Ill. 1000 w. Eng & Min Jour—Oct. 21, 1899. No. 30277.

Chlorination.

The Chlorination of Gold Ores at Mount Morgan, Queensland. Edgar Hall. A description of this plant, which is probably the largest chlorination mill in the world. 1200 w. Eng & Min Jour—Oct. 7, 1899. No. 30082.

Comstock.

The Comstock Lode. L. P. Gratacap. An account of this great deposit and the scheme under way for unwatering the fissure after almost twenty years of idleness. 1500 w. Sci Am Sup—Oct. 28, 1899. No. 30361.

Formation.

The Gold-Bearing Formation of Stephenson County, Illinois. Oscar H. Hershey. A brief discussion of an isolated deposit in appreciable, but not economical quantities. 1200 w. Am Geol—Oct., 1899. No. 30269 D.

Gold Determination.

The Iodometric Determination of Gold. F. A. Gooch and Frederick H. Morley. Gives results of experiments. 1400 w. Am Jour of Sci—Oct., 1899. No. 29936 D.

Gold District.

Buffalo Hump. Don Maguire. Facts about a rich and promising region which has been the scene of great excitement during the past year. 2500 w. Mines & Min—Oct., 1899. No. 30149 C.

Gold-Dredging.

Gold-Dredging in New Zealand. Historical sketch of the dredging industry in Otago, from a paper by W. H. Cutten, with tables showing dimensions and cost, operations and returns. 3700 w. N Z Mines Rec—Sept. 16, 1899. No. 30378 B.

Idaho.

The Twin Springs Placer Company. Idaho. H. L. J. Warren. Illustrated description of the working of these rich deposits. 1700 w. Eng & Min Jour—Sept. 30, 1899. No. 29953.

New Mexico.

Developments in Northern New Mexico. Notes concerning works in the northern part are given in part first. 900 w. Eng & Min Jour—Sept. 30, 1899. Serial. 1st part. No. 29952.

New Zealand.

Quartz-Mining in New Zealand. Report concerning the increase in gold returns from this source. 1700 w. N Z Mines Rec—Aug. 16, 1899. No. 29938 B.

Placers.

Wonderful Dry Placers. A. W. Gifford. Reports that placers of the Jarilla Mountains, New Mexico, yield coarse gold worth $100 a yard. 1200 w. Ores & Met—Oct., 1899. No. 30323.

Siberia.

Lease of Gold-Bearing Land in Siberia. A translation of a circular, issued by the Ministry of Agriculture and Domains, in regard to leasing six tracts of land. 700 w. U. S. Cons Reports, No. 562—Oct. 25, 1899. No. 30337 D.

Slocan District.

A Description of the Bosun Mine. Howard West. Illustrated historical description. 2700 w. B C Min Rec—Aug., 1899. No. 30058 C.

Sulphides.

Concentration of Auriferous Sulphides in California. Considers the value of concentrating machines and the canvas plant. 1400 w. Min & Sci Pr—Sept. 23, 1899. Serial. 1st part. No. 29955.

Utah Mine.

The Daly West Mine, Park City, Utah. H. L. J. Warren. An outline sketch of this lead-silver mine, with illustration and map. 2000 w. Eng & Min Jour—Oct. 14, 1899. No. 30216.

Ymir Mine.

Notes on Ymir Mine and Its Mill Practice. S. S. Fowler. Read before the Can. Min. Inst. Describes the region and its deposits, the progress in mining and the milling practice. 2800 w. Can Min Rev—Sept. 30, 1899. No. 30034 B.

IRON AND STEEL.

Blast Furnace Gases.

See Gas Engineering.

Castings.

See Mechanical Engineering, Foundries.

Charcoal By-Products.

Influence of the By-Products of Charcoal Manufacture on the Charcoal Pig-Iron Industry. H. O. Chute. Shows the dependence of one industry upon another, and the present development of charcoal iron manufacture. 1500 w. Ir Age—Oct. 5, 1899. No. 30042.

Crucible Steel.

Improved Martin Steel or Crucible Steel (Verbesserte Martinstahl oder Tiegelstahl). Otto Thallner. A discussion of the differences between Bessemer, open-hearth, and crucible steel, showing how open-hearth steel may be remelted in the crucible to advantage. Two articles. 6000 w. Stahl und Eisen—Sept. 15, 1899. No. 30462 each D.

Heat Treatment.

Problems of Heat Treatment. Discusses malleable work, chemistry and carbon conversion and the need of perfect combustion. 2500 w. Ir Trd Rev—Oct. 26, 1899. No. 30380.

India.

The Iron Ores of India. Details of the iron ore supplies as given in report of Major Mahon. 4000 w. Ir & Coal Trds Rev—Oct. 20, 1899. No. 30525 A.

Ingots.

Evans' Ingot Stripper. Illustrated description of a machine designed to strip two ingots at the same time, the ingots worked being about 6 ft. high, though both long and short pieces can be stripped with equal ease. 1500 w. Engr, Lond—Oct. 13, 1899. No. 30308 A.

Iron Founding.

See Mechanical Engineering, Foundries.

Open-Hearth.

A New Open-Hearth Steel-Making Process. Alexander Sattmann, in *Stahl und Eisen*. Illustrated description of the process with discussion of the technical points. 3200 w. Ir & Coal Trds Rev—Oct. 20, 1899. No. 30524 A.

Rail Making.

Early Rail-Making in the United States. John Fritz. Extracts from an address at a meeting of the Min. and Met. Section of the Franklin Inst. Brief historical review. 2500 w. R R Gaz—Oct. 20, 1899. No. 30262.

Steel.

Recent Investigations in Steel. H. Sylvester. From the presidential address before the Staffordshire Iron and Steel Inst. Reviews the chief facts that have been ascertained in connection with the hardening of steel and the theories advanced to explain the phenomena. 2000 w. Ir Trd Rev—Oct. 26, 1899. No. 30381.

MINING.

Accounts.

Mine Accounts. John E. Hardman. Read before the Nelson meeting of the Canadian Min. Inst. Explains a method of cost accounting. 7800 w. Can Min Rev—Sept. 30, 1899. No. 30032 B.

Borings.

The Recovery of the Ropersole Borehole, Kent Coalfields. W. J. Cousins. An illustrated account of overcoming a difficulty arising during deep boring. 1300 w. Ir & Coal Trds Rev—Oct. 13, 1899. No. 30332 A.

China.

Chinese Mining Regulations. A copy of amendments to the regulations governing mines. 900 w. U. S. Cons Reports, No. 553—Oct. 14, 1899. No. 30170 D.

Colorado.

Evolution of Mining and Ore Treatment in Colorado. Thomas Tonge. A comprehensive exposition of the effect of improved appliances, exact methods and economical management in developing low-grade properties and eliminating the element of chance in mining. 3000 w. Engineering Magazine—Nov., 1899. No. 30497 B.

Deep Mines.

Systems for the Raising of Water from Deep Mines. W. M. Epton. Read before the Johannesburg Mech. Engs'. Assn. Enumerates several systems and discusses the loss in getting the power from boilers on the surface to the pump underground. 2500 w. Ir & Coal Trds Rev—Oct. 6, 1899. No. 30224 A.

Deep Pumping.

Deep Pumping at Elliot Colliery, New Tredegar, Monmouthshire. E. M. Hann. Read before the South Wales Inst. of Engs. States existing conditions and gives an illustrated description of the main features of the plant. 2800 w. Col Guard—Sept. 22, 1899. No. 29973 A.

Diamond Drilling.

Practical Notes on Diamond Drilling. H. M. Lane. Illustrated description of the drilling apparatus and how to use it under various conditions. 3500 w. Mines & Min—Oct., 1899. No. 30142 C.

Electric Power.

Electricity as Applied to Mining. J. R. Bainton. Read before the N. S. W. Chamber of Mines. Gives a review of the applications made in the mining industry and the results, with comparison with results obtained by using compressed air. Discussion. Ill. 5000 w. Aust Min Stand—Aug. 31, 1899. No. 30158 B.

Electric Power Plant in the Julius Mine at Brüx (Elektrische Kraftübertragungsanlage auf dem Aerarischen Julius III. Schacht in Brüx). Describing the very complete plant used for pumping, lighting, hauling, and ventilating, in an important mining district in Bohemia. 2000 w. 2 plates. Oesterr f Berg u Hüttenwesen—Sept. 16, 1899. No. 30449 B.

The Plant at the Witkowitz Coal Mine at Dombrau (Die Anlagen der Witkowitzer Steinkohlengruben in Dombrau). A. Fillunger. A fully illustrated account of an important mining plant in Moravia. Three articles. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 23, 30, Oct. 7, 1899. No. 30451 each B.

Winding and Pumping Installations at the Witkowitz Colliery (Dombrau). A. Fillunger, in *Oesterreichische Zeitschrift für Berg und Huttenwesen.* An illustrated description of the electrical power plant. 2400 w. Col Guard—Oct. 20, 1899. No. 30522 A.

Explosives.

Experiments with Liquefied Oxygen as an Explosive (Essai de l'Oxyliquit comme Explosif). An account of experiments recently made in Germany with liquid oxygen as a safety mining explosive. 2000 w. Revue Technique—Oct. 10, 1899. No. 30414 D.

Safety Explosives and Their Ignition. Particulars concerning explosives and igniters taken from report to the Austrian Government. Ill. 2200 w. Col Guard—Oct. 6, 1899. No. 30234 A.

Fans.

A Peculiarity in the Measurement of a Fan's Industrial Yield by Means of a Thin-Edged Wicket. S. Hanappe. Communicated to the Société des Ingénieurs des Mines du Hainaut. Explains how the pressure should be taken and the cause of incorrectness. 2000 w. Col Guard—Oct. 6, 1899. No. 30236 A.

Fan Speed and Pressure Recorders at the Roche-la-Moliere et Firminy Collieries, Loire, France. M. Denogent. Describes the apparatus used, which gives correct indications and requires but little power. 1200 w. Col Guard—Sept. 29, 1899. No. 30130 A.

Haulage.

Automatic Chain and Rope Haulage at the Rheinpreussen Mine at Homberg (Automotorische Ketten und Seilförderung auf der Zeche Rheinpreussen bei Homberg). With plate of details showing the method of driving the cables by the water of the mine, also the manner of connecting the cars. 2500 w. 1 plate. Glückauf—Oct. 1, 1899. No. 30455 B.

Bottom Haulage Landing at the Mammoth Mine. Howard N. Eavenson. Illustrated detailed description of the arrangement and operation. 3000 w. Eng News—Oct. 12, 1899. No. 30180.

Chain and Rope Haulage at the Rhein-Preussen Colliery, Rhenish-Prussia. From a communication by W. M. to *Glückauf.* Illustrated description of an installation for utilizing mine water. 2500 w. Col Guard—Oct. 20, 1899. No. 30521 A.

Hoisting.

The Mähnert Hoisting Apparatus (E. Mähnert's Auftrieb-Förderverfahren). An illustrated description of an improved device for elevating materials by utilizing their buoyancy in a column of water. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 14, 1899. No. 30452 B.

Miner's Lamp.

The Portable Electric Miner's Lamp. Sydney F. Walker. Discusses whether the electric current shall be furnished by a primary or a secondary battery. 2500 w. Col Guard—Sept. 29, 1899. No. 30-132 A.

Mining Law.

The Sale of Coal Under the Weights and Measures Act of 1889. Brief statements of noteworthy adjudications pronounced by the Queen's Beach Divisional Court. 2800 w. Col Guard—Oct. 13, 1899. No. 30316 A.

Mining Machinery.

Care and Maintenance of Mining Machinery. G. D. Rice. Discusses the care necessary for the various kinds of machines, and mentions considerations to be taken into account. 2800 w. Am Gas Lgt Jour—Oct. 16, 1899. No. 30214.

Oil Engines.

Oil Engines as Pump Motors Underground. George L. Kerr. Discusses the various methods of ridding mines of water and gives plan and elevation showing the general arrangement of oil engine and pump for this purpose. 1600 w. Col Guard—Oct. 6, 1899. No. 30237 A.

Pit-Heads.

Pit-Head Pulley Framings. Their Design and Construction. S. A. Everett. Read before the South Wales Inst. of Engs. A survey of the development and discussion of proper construction. 2800 W. Col Guard—Sept. 29, 1899. No. 30-128 A.

Prussia.

Progress in Mining in Prussia During 1898 (Versuche und Verbesserungen beim Bergwerksbetriebe in Preussen während des Jahres 1898). A very complete review of the year's progress, with numerous illustrations. Four articles, 8000 w. Glückauf—Sept. 16, 23, Oct. 1, 7, 1899. No. 30454 each B.

Pumping.

Deep Mine Pumping. W. M. Epton. Abstract of a paper read before the Johannesburg Mech. Engs. Assn. Enumerates several systems, giving the writer's views on each. 2100 w. Am Mfr & Ir Wld.—Oct. 26, 1899. No. 30379.

Electrical Pumping in South Staffordshire, England. W. H. Booth. describes methods used for keeping the water out of the mines. 2300 w. Mines & Min—Oct., 1899. No. 30151 C.

Sampling.

Some Notes on Mine Surface Sampling. S. H. Pearce. Discusses methods and the difficulties met. Ill. 6000 w. Jour Chem & Met Soc of S Africa—Aug., 1899. No. 30299 E.

Small Economies.

The Small Economies in Mining Howard West. Read before the Can. Min. Inst. Relates to conditions in the Slocan district, calling attention to various points neglected. 4500 w. Can Min Rev—Sept. 30, 1899. No. 30035 B.

Ventilation.

Report of the Victorian Mines Ventilation Board. Abstract of report by the board appointed to deal with the applications received for a bonus of £1,000 offered by the Victorian Government for the best method of ventilating mines. 1500 w. Ir & Coal Trds Rev—Oct. 13, 1899. No. 30333 A.

Utilizing for Ventilation the Whole Cross-Section of a Winding Shaft. Bergassessor Dehnke in *Glückauf*. Illustrated description of arrangement to be provided for the Neuenühl Colliery, with its advantages over other described arrangements. 2200 w. Col Guard—Sept. 29, 1899. No. 30131 A.

MISCELLANY.

Diamonds.

Emigrant Diamonds in America. William Herbert Hobbs. A study of the origin of diamonds found in the neighborhood of the Great Lakes. Ill. 3300 w. Ap Pop Sci M—Nov., 1899. No. 30343 D.

Manganese.

Manganese and Related Metals. J. Ohly. Information concerning manganese and its properties is given in part first. 1500 w. Min Rept—Oct. 19, 1899. Serial. 1st part. No. 30338.

Petroleum.

Crude Petroleum and Its Products as Fuel. H. Tweddle. Much information concerning these products and the best methods for burning. 2800 w. Eng & Min Jour—Oct. 14, 1899. Serial. 1st part. No. 30218.

Salt.

The Transformation of the Alpine Salt Works (Ueber die Umgestaltung des Alpinen Salzbergbaues). A. Aigner A review of the improved methods which have been introduced since 1863, and the economy which has resulted. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 16, 1899. No. 30450 B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

A Train in the River. Illustrated account of an accident which plunged seven cars and a locomotive into the upper Niagara river. 600 w. Ry Age—Sept. 29, 1899. No. 29999.

Train Accidents in the United States in August. Detailed list and classified summary. 4000 w. R R Gaz—Oct. 20, 1899. No. 30264.

Braking.

Some of the Problems in Train Braking. G. L. Wilkinson. A general discussion of problems relating to the effective working of brakes. 3700 w. R R Gaz—Oct. 13, 1899. No. 30178.

Train Service.

The Winter Train Services. Charles Rous-Marten. Considers the changes on British roads, and a note concerning the "Nord" express of France. 700 w. Engr, Lond—Oct. 6, 1899. No. 30232 A.

Transportation.

The Revolution in Railway Transportation. Editorial discussion of the relation of large locomotives to the problem of cheap transportation of bulk freights, especially considering the new and powerful locomotive of the Illinois Central R. R. 2700 w. Eng News—Oct. 26, 1899. No. 30373.

FINANCIAL

Profits.

British Railway Profits. An editorial review of the traffic returns and working expenditure. 1800 w. Engng—Sept. 22, 1899. No. 29965 A.

Ry. Statistics.

Statistics of Railways in the United States for the year 1898. Extracts from tables given in advanced sheets of "Poor's Manual." 500 w. Eng News—Oct. 15, 1899. No. 30065.

LEGAL.

Rates.

The Kansas City, Pittsburg and Gulf Division. The decision of Judge Thayer, of the Federal Court at St. Louis, ordering the receivers to restore rates to the basis which prevailed before the trouble. 1200 w. Ry Age—Oct. 6, 1899. No. 30111.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Repair and Instruction Rooms of the St. Paul & Duluth Ry. G. R. Parker. Illustrated detailed description of apparatus for repair, testing and instruction purposes. 1400 w. Ry Mas Mech—Oct., 1899. No. 30164.

Handling Freight Trains Partially Equipped with Air. Upon the instructions of C. L. Nichols, Supt. of the C., R. I. and P. R. R., with portion of a recent discussion at the Air Brake Men's Assn. 1500 w. R R Gaz—Oct. 6, 1899. No. 30084.

Car Doors.

Door Fastenings for End-Dump Cars. J. E. Johnson. Illustrated description of the device and its operation. 1500 w. Eng News—Oct. 26, 1899. No. 30370.

Car Lighting.

A New System of Train Lighting. Abstract from the *Revue Géneralé des Chemins de Fer.* Reviews briefly the arrangements of the best known systems and describes in detail one recently applied experimentally by the Paris, Lyons and Mediterranean Co. Ill. 2400 w. Elect'n, Lond—Oct. 13, 1899. No. 30331 A.

Car Lighting with Pintsch Gas, City Gas and Acetylene Mixture. An explanation of why city gas and mixtures with acetylene are not used in the United States. 700 w. Am Engr & R R Jour—Oct., 1899. No. 30013 C.

Center of Gravity.

Simple Method of Determining the Center of Gravity of Locomotives. G. R. Henderson. Describes method. Ill. 500 w. Am Engr & R R Jour—Oct., 1899. No. 30009 C.

Coupling.

The Progressive Development of the English Coupling. W. D. Phillips. A short sketch showing the stages by which The English coupling has diverged from the American form. 600 w. R R Gaz—Oct. 20, 1899. No. 30266.

Dining Cars.

Model Modern Dining Cars for the Southern Railway. Illustrated description. 400 w. Loc Engng—Nov., 1899. No. 30505 C.

Draft Beams.

Metal Draft Beams. A general discussion, with special description of various designs. Ill. 4200 w. R R Gaz—Oct. 13, 1899. No. 30174.

English Railway.

Notes on the Great Eastern Railway of England. A. M. Bell. Illustrates and describes the equipment, and comments

on the excellent feeling between master and men. 1700 w. Loc Engng—Nov., 1899. No. 30506 C.

Hose.

See Mechanical Engineering, Materials.

Intercepting Valve.

Intercepting Valve of the Pittsburg Compound Locomotive. R. Atkinson. Special drawings showing valve in simple and compound positions, with description. 1000 w. Loc Engng—Oct., 1899. No. 30003 C.

Locomotive Boilers.

Heat Transmission in Locomotive Boilers. William Forsyth. Discusses the materials for heating surfaces and the most advantageous lengths of tubes. 2200 w. Am Engr & R R Jour—Oct., 1899. No. 30008 C.

Locomotive Designs.

Two Locomotive Designs. Drawings and description of two designs of advanced practice, one a heavy freight engine, the other a heavy passenger locomotive. 1300 w. R R Gaz—Oct. 27, 1899. No. 30366.

Locomotive Practice.

Locomotive Practice in France and Switzerland. The skill of Swiss engineers in building engines capable of climbing steep grades, etc. Ill. 1000 w. Transport—Oct. 13, 1899. No. 30328 A.

Locomotive Trade.

The Locomotive Trade of Great Britain. Discusses the position of the trade and the reasons for sending orders abroad. 3500 w. Engr, Lond—Oct. 13, 1899. No. 30306 A.

Locomotives.

Australian Consolidation Engine. Illustrated description. 350 w. Loc Engng—Oct., 1899. No. 30005 C.

Express Passenger Locomotive for the Great Central Railway. Illustrated detailed description of engine of the four-coupled inside cylinder type, with a four-wheeled bogie at the leading end. 1600 w. Engng—Sept. 29, 1899. No. 30126 A.

Painting Locomotive Engines. Historical review giving early and modern practice, particularly in England, with discussion of methods and constituents. 3200 w. Engr, Lond—Oct. 6, 1899. No. 30228 A.

Plans for the Systematic Investigation of Locomotives (Ueber die Aufstellung von Plänen für die Regelmässigen Untersuchungen der Lokomotiven). With a number of tables and a graphical scheme for the distribution of inspection throughout the year. 2000 w. Glaser's Annalen—Oct. 1, 1899. No. 30441 D.

Ten-Wheel Freight Locomotives. Illustration and principal dimensions of engines for the Chicago Great Western Ry. 300 w. Am Engr & R R Jour—Oct., 1899. No. 30011 C.

The Largest Locomotive in the World; Illinois Central R. R. Full illustrated detailed description with two-page plate. 1300 w. Eng News—Oct. 26, 1899. No. 30368.

The New Six-Coupled Express Engines for the Northeastern Railway. Charles Rous-Marten. Brief note and photograph of engine already described in issue of July 21. 800 w. Engr, Lond—Sept. 22, 1899. No. 29976 A.

The New York Central Class P Mogul Freight Locomotive. Engravings, general dimensions and interesting data. 900 w. R R Gaz—Sept. 29, 1899. No. 29942.

The 116-Ton Illinois Central Twelve-Wheel Locomotive. Engravings and descriptive specifications with general remarks. 1000 w. R R Gaz—Sept. 29, 1899. No. 29940.

Twelve-Wheel Brooks Locomotive, D. L. & W. Ry. An illustrated detailed description of a powerful freight locomotive, with critical comments. 2500 w. Ry & Engng Rev.—Oct. 14, 1899. No. 30212.

Weight and Efficiency of Locomotives. Ira C. Hubbell. On the efficiency of locomotives as affected by the percentage of weight on drivers to total weight. 1200 w. Ry Age—Oct. 6, 1899. No. 30110.

Ore Cars.

112,000-Pound Steel Ore Cars in Scotland. Illustrated description of cars introduced on the Caledonian Railway. 700 w. Am Engr & R R Jour—Oct., 1899. No. 30010 C.

Signal Lamps.

Maintenance and Inspection of Signal Lamps, A. T. & S. Fé Ry. Information supplied by J. S. Hobson, signal engineer, concerning inspection of lamps in service, repairs, tests, etc. 2200 w. Ry & Engng Rev—Sept. 30, 1899. No. 29997.

NEW PROJECTS.

Africa.

The Railways of Africa. Gives a map showing the principal lines completed, under construction and projected, with particulars. 3500 w. Eng News—Sept. 28, 1899. No. 29959.

China.

Imperial Chinese Railways. J. Grant Birch. A report of recent progress, and related matters. 3500 w. Engng—Oct. 20, 1899. No. 30511 A.

Engadine.

The Engadine-Orient Railway (Der Engadin-Orientbahn). Lieut. Buchholz.

A paper before the German Railway Society upon the proposed railway to connect the eastern cantons of Switzerland with the Tyrol. 3000 w. Glaser's Annalen—Oct. 15, 1899. No. 30442 D.

Hawaii.

A New Railway for Hawaii. Information concerning a road to be known as the Kohala & Hilo Ry., having a trackage of 130 miles. 900 w. Ry Age—Oct. 6, 1899. No. 30109.

India.

The Kalka-Simla Railway. Details and plans of this project for bridging the mountain barrier between Kalka and the hill capital. 2800 w. Ind & East Engr—Sept., 1899. No. 30301 D.

PERMANENT WAY AND FIXTURES.

Ballast.

Handling Ballast on the Michigan Central. Illustrates and describes the method of loading and distributing gravel. 1600 w. R R Gaz—Oct. 13, 1899. No. 30176.

Fuel.

Coke as Locomotive Fuel. Discusses its use on the Boston & Maine R. R. Also editorial. Ill. 300 w. Am Engr & R R Jour—Oct., 1899. No. 30012 C.

Does Increase of Train Speed Entail Increase of Fuel Consumption? Editorial giving evidence that engines hauling very fast trains burn less coal per car mile than those hauling slower trains. 1000 w. Loc Engng—Oct., 1899. No. 30004 C.

Improvements.

Improvements on the Illinois Central near New Orleans. Describes the arrangement of a new yard, and briefly notes other features. 800 w. R R Gaz Sept. 29, 1899. No. 29943.

Prolongation of the Orleans Line to the Quai D'Orsay. From *La Nature.* Illustrated detailed description. 1200 w. Sci Am Sup—Sept. 30, 1899. No. 29931.

Light Railways.

Remarkable Extension of Light Railways in Belgium. Information concerning results attained in less than fourteen years. 2000 w. Engr, Lond—Sept. 22, 1899. No. 29977 A.

Maintenance.

The Organization of the Maintenance of Way Department. E. E. Russell Tratman. Extracts from an address before the first annual convention of the Eastern Maintenance of Way Assn., at Portland, Me. 4500 w. Ry & Engng Rev—Sept. 30, 1899. No. 29996.

Mountain Road.

The Railway from Laqueuille to Mont-Dore (Le Chemin-de-Fer de Laqueuille au Mont-Dore). G. Leugny. With topographical maps, profile, sections of tunnels, and general details of the railway recently completed in Puy-de-Dôme, France. 2500 w. Revue Technique—Sept. 10, 1899. No. 30411 D.

Organization.

The Organization of Railway Engineering and Maintenance of Way Departments. E. E. Russell Tratman. Abstract of paper read at meeting of the Eastern Maintenance of Way Assn., at Portland, Me., somewhat modified. Gives examples now in force on some leading railways. 4200 w. Eng News—Oct. 19, 1899. No. 30259.

Signalling.

Sargent's Automatic Semaphore. Illustrated description of a signal worked by a motor placed in a box at the top of the post. 700 w. R R Gaz—Oct. 13, 1889. No. 30175.

Signalling on the Dover Tramways. Illustrated description of an ingenious system and its method of working. 1100 w. Elec Engr, Lond—Oct. 13, 1899. No. 30303 A.

Signalling Without Contact. W. S. Boult. Read at Dover meeting of the British Assn. Describes a system specially suitable for fog signalling. 4500 w. Elec Rev, Lond—Sept. 22, 1899. Serial. 1st part. No. 30039 A.

Simplon.

The Construction of the Simplon Tunnel (Der Bau des Simplon-Tunnels). A general review of the conditions which preceded the undertaking, and an account of the progress up to date. Two articles. 3500 w. Schweizerische Bauzeitung—Oct. 7, 14, 1899. No. 30434 each B.

Speeds.

French and English Railway Speeds. Philip Burtt. Principally an account of what is accomplished in France, and the features which differ from conditions in England. 2200 w. Transport—Oct. 13, 1899. No. 30327 A.

The Fastest Long-Distance Train in the World. Charles Rous-Marten. Information from observation of the Sud Express run from Paris to Spain or Portugal. 2400 w. Engr, Lond—Oct. 20, 1899. No. 30517 A.

Stations.

New York Central Improvements at Albany. Illustrated account of improvements embracing the reconstruction of bridge across the Hudson River, the erection of a new station, and elevation of tracks. 1000 w. Ry Age—Oct. 27, 1899. No. 30509.

The New Pennsylvania Railroad Passenger Terminal at Jersey City. Edward

B. Gumaer. Illustrates and describes the recent improvements. 2800 w. Eng News—Sept. 28, 1899. No. 29960.

The Waverley Station, Edinburgh. An illustrated detailed description of the enlargement, nearly completed, of the North British Railway Company's Waverley station. 4000 w. Engng—Oct. 6, 1899. Serial. 1st part. No. 30225 A.

The Reconstruction of the Railway Stations at Tours (La Transformation des Gares de Tours). MM. Couvrat & Sabouret. A very full account of the improvements recently completed at this important railway center of France. 7500 w. 4 plates, Rev Gen de Chemins de Fer—Sept., 1899. No. 30456 F.

Subway.

See Civil Engineering Construction.

Switch.

Electrically Operated Switches (Weiche mit Elektrischem Betrieb). Dr. Russner. A description of the Jüdel system, by which only a single circuit is necessary for operating the switch in either direction. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 22, 1899. No. 30417 B.

Electrical Switches. William Baxter, Jr. Illustrates and describes various types. 2000 w. Am Mach—Oct. 12, 1899. Serial. 1st part. No. 30166.

Ties.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Continued discussion of paper by W. W. Curtis. 3300 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30350 E.

Track Tank.

Supplying Water to Moving Trains (Alimentation d'Eau des Locomotives en Marche). An illustrated description, mainly of English and American apparatus for scooping water from a tank between the rails and delivering it to a tender of a moving train. 1200 w. Génie Civil—Sept. 16, 1899. No. 30401 D.

Uganda.

The Uganda Railway (Der Uganda Eisenbahn). Col. Fleck. A very full account of the progress of work, tabulated from the start in 1896 to the present time, with map and profile. 4500 w. Glaser's Annalen—Oct. 15, 1899. No. 30443 D.

Water Stations.

Pumping Engines for Water Stations. Extracts from a report presented at the Detroit meeting of the Assn. of R. R. Supts. of Bridges and Buildings. 2200 w. R R Gaz—Oct. 27, 1899. No. 30367.

Yukon Ry.

The White Pass and Yukon Ry. A description of the completed portion and its equipments, with maps and illustrations. 1200 w. Eng News—Oct. 5, 1899. No. 30063.

TRAFFIC.

Great Britain.

One of the Busiest Railroads in the World. E. L. Corthell. An account of the Lancashire & Yorkshire Railway. Ill. 2100 w. R R Gaz—Oct. 20, 1899. No. 30263.

Rates.

The K. C., P. & G. Freight-Rate Injunction. Gives facts presented by the Atchison, Topeka & Santa Fé during the recent contest, showing difficulties to be met by new roads in thinly settled country. 1800 w. R R Gaz—Oct. 20, 1899. No. 30265.

STREET AND ELECTRIC TRAMWAYS

Argentina.

Electric Railway Practice in Argentina. E. Manville. An illustrated description and historical account. 5000 w. St Ry Jour—Oct., 1899. No. 30189 D.

Austria-Hungary.

Electric Railway Practice in Argentina. Hungary. E. A. Ziffer. A review of the history, with a description of the principal types and methods of construction. 4500 w. St Ry Jour—Oct., 1899. No. 30188 D.

Bombay.

Tramways in Bombay. A short report of the street-car system. 500 w. U. S. Cons Repts, No. 548—Oct. 9, 1899. No. 30086 D.

Car Equipment.

Care of Car Equipment. J. H. Vanderveer. Views of the superintendent of shops, Brooklyn Heights R. R. Co., concerning the proper care. Discussions. Read at convention of the Am. St. Ry. Assn. 9000 w. St Ry Rev—Oct. 19, 1899. No. 30293 C.

Chicago Elevated.

The Elevated Railroads of Chicago. Illustrated detailed description. 8500 w. St Ry Rev—Oct. 15, 1899. No. 30241 C.

Chicago.

The Street Railways of Chicago. Illustrated detailed account. 19500 w. St Ry Rev—Oct. 15, 1899. No. 30240 C.

Compressed Air.

Compressed Air in Traction Service. C. D. Wood, Jr. On the applications to street-railway work especially in New York. 1200 w. Yale Sci M—Oct., 1899. No. 30162 C.

Pneumatic Tramways (Tramways Pneumatiques). An illustrated description of the Popp system of compressed air motors, as used in Paris. 2000 w. Revue Technique—Sept. 10, 1899. No. 30409 D.

Conduits.

Underground Conduit System for London United Tramways. Gives plans with designs for cars and poles to be used on the trolley sections. 1500 w. Tram & Ry Wld—Oct. 5, 1899. No. 30251 A.

Electrolysis.

Electrolysis. A statement of experience in Brooklyn. 700 w. Eng Rec—Oct. 21, 1899. No. 30284.

Freight.

The Right to Do Freight Business on Street Railroads. Gives the substance of Judge Hatch's decision, sustaining the right to carry freight. 600 w. R R Gaz—Oct. 20, 1899. No. 30267.

Fuel Economy.

See Mechanical Engineering, Steam Engineering.

Germany.

Electric Railway Practice in Germany. Louis J. Magee. Illustrates and describes the interesting features of electrical operation in the country named. 7000 w. St Ry Jour—Oct., 1899. No. 30185 D.

The Street Railway System of Hanover, Germany. Woolsey McA. Johnson. Brief illustrated description. 2200 w. Elec Wld & Engr—Oct. 14, 1899. No. 30501.

Great Britain.

Electric Railway Practice in Great Britain. Sidney H. Short. An illustrated review of roads and equipment, especially at Glasgow. 6000 w. St Ry Jour—Oct., 1899. No. 30186 D.

Investments.

Investments in Street Railways. Charles T. Yerkes. Discussion how they can be made secure and remunerative. Discussion. 9000 w. St Ry Rev—Oct. 18, 1899. No. 30295 C.

Laon, France.

Electric Traction at Laon. Illustrated description of a short electric railway with some steep gradients. 700 w. Tram & Ry Wld—Oct. 5, 1899. No. 30252 A.

The Electric Railway from the Laon Station to the City (Le Chemin de Fer Electrique de Laon-Gare à Laon Ville). With views and profile of the tramway from the station to the height upon which the city is situated. 1500 w. L'Electricien—Oct. 7, 1899. No. 30484 B.

Leeds, Eng.

Electric Tramway Extension at Leeds. Illustrates and describes interesting permanent way reconstruction, including considerable bonding, and also overhead electric equipments. 1500 w. Tram & Ry Wld—Oct. 5, 1899. No. 30250 A.

Mileage.

Car Mileage. H. C. Mackay. Read at convention of Am. St. Ry. Assn. The necessity of securing an equitable and standard unit. Discussion. 12500 w. St Ry Rev—Oct. 19, 1899. No. 30294 C.

Motor Control.

The Westinghouse Electro-Pneumatic System of Motor Control and the Baldwin New Trucks for Heavy Electric Cars. Illustrated description of a new system of controlling any number of electric motors from one point; also illustrated description of the new trucks. 3700 w. R R Gaz—Oct. 13, 1899. No. 30177.

Motor Rating.

Notes on Railway Motor Rating. John Lundie. Suggests a rating based upon average output. Also editorial. 900 w. Elec Wld & Engr—Oct. 21, 1899. No. 30273.

Motors.

The Service Performance of Railway Motors. W. B. Potter. A discussion of the horse-power, tractive effort, etc. 1600 w. St Ry Jour—Oct., 1899. No. 30190 D.

Municipal Ownership.

Municipal or Private Ownership and Control. Charles Carroll Brown. Discusses certain phases of the transportation problem. 1800 w. Munic Engng—Oct., 1899. No. 29985 C.

Municipal Transportation.

Electric Railway Practice in America as Exemplified in Chicago. Reviews American experience and explains the latest and best practice, giving an illustrated detailed description of the Chicago construction. 14500 w. St Ry Jour—Oct., 1899. No. 30184 D.

Financial Characteristics of the Large City Transportation Systems of the World. Edward E. Higgins. Tabulated results of investigations of thirty cities are given, with explanations and discussion of different systems and their development. 3500 w. St Ry Jour—Oct., 1899. No. 30187 D.

Rail Bonding.

Rail Bonds. H. P. Brown. A statement of recent experience. 700 w. Eng Rec—Oct. 21, 1899. No. 30283.

Recent Experience in Rail Bonding for Electric Railways. Harold P. Brown.

Condensed from a paper presented at the Toronto meeting of the Am. Soc. of Munic. Imp. Brief reports from various places, and a discussion of methods giving best results. 1000 w. Eng News—Oct. 12, 1899. No. 30182.

Rapid Transit.

The New York Rapid Transit Situation. States the conditions on which contractors for this work are to submit bids. The contract is one of the largest placed since Eads contract for the Mississippi jetties. 1800 w. Eng Rec—Oct. 28, 1899. No. 30388.

The New York Rapid Transit Tunnel. Gives an illustrated description of the construction as planned, the route, stations, equipment, etc. 6000 w. Ir Age—Oct. 19, 1899. No. 30243.

Rouen.

The Electric Tramway Between Rouen and Bonsecours (Le Tramway Electrique de Rouen à Bonsecours). L. Huret. With illustrations of this suburban tramway, and map and profile showing the heavy grades. 1800 w. L'Electricien—Sept. 23, 1899. No. 30483 B.

Small Plant.

A Typical Small Street-Railway Plant. Harry J. Bean. Illustrates and describes the First Street Electric Railroad Company's system, of San Jose, Cal., as an example of most of the electric railway plants in the small cities of the west. 1400 w. Jour of Elec—Sept., 1899. No. 30206.

Toronto, Can.

An Important Canadian Tramway System. Illustrates and describes the tramways of Toronto. 1800 w. Tram & Ry Wld—Oct. 5, 1899. No. 30253 A.

Tracks.

Construction and Maintenance of Street-Railway Tracks. Edward Butts. Read at the convention of the Am. St. Ry. Assn. Presents a construction which experience has shown to be satisfactory. Also discussion. 5000 w. St Ry Rev—Oct. 20, 1899. No. 30339 C.

Recent Street Track at Rochester, N. Y. Illustrated description of rails on longitudinal concrete beams, with crossties of old rails. 500 w. Eng Rec—Oct. 21, 1899. No. 30280.

Traffic.

Heavy Traffic on the Chicago Loop. Report concerning the handling of the heavy traffic on Oct. 9—Chicago Day. 900 w. Eng News—Oct. 19, 1899. No. 30258.

Train Service.

Train Service and Its Practical Application. Ira A. McCormack. Read at convention of Am. St. Ry. Assn. Gives methods which the writer has found useful in cases under his observation. Discussion. 9000 w. St Ry Rev—Oct. 20, 1899. No. 30340 C.

United Kingdom.

The Early Future of Electric Tramways in the United Kingdom. Discusses the outlook and progress expected in the near future. 2000 w. Tram & Ry Wld—Oct. 5, 1899. No. 30254 A.

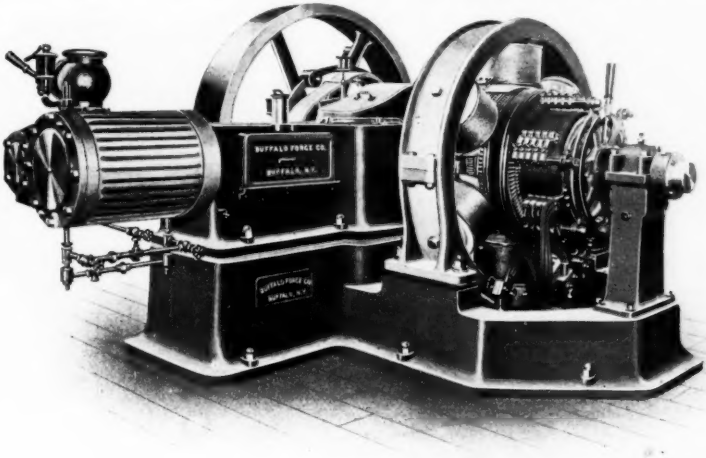
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

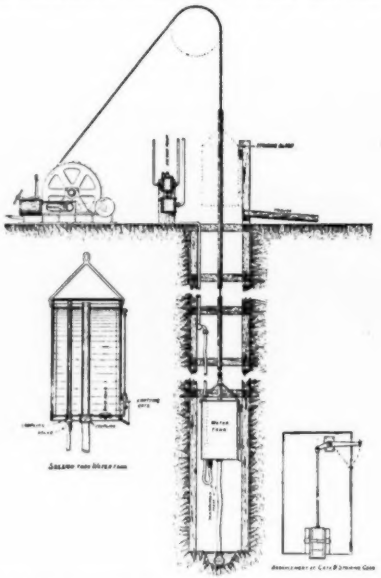
Buffalo Center-Crank Engine.

THE cut shown herewith illustrates one of the several types of steam engines now being turned out by the Buffalo Forge Company, of Buffalo, N. Y. The general appearance of this engine is well shown by the illustration. The heavy cast-iron subbase with which it is supplied furnishes a solid support to which to bolt the engine bed, and at the same time raises the engine sufficiently for the fly wheels to clear the floor or foundation. The frame is also a single casting, and is of the center crank type, with overhead cylinder cast on. In the larger sizes the cylinder head only is cast on the frame and the cylinder is bolted to it. In the smaller sizes the cross head guides are bored out at the same setting and same operation, and with the same bar with which the cylinder is bored. The same statement applies to the boring of the guides and facing the cylinder head on the larger sizes. The importance of this method of construction at once appeals to the engineer who has had experience with "hot boxes" caused by the slides being slightly out of line with the cylinder. The cross head is fitted with cast shoes lined with the best babbitt metal peined in, and a ready means of adjustment is provided for taking up the wear between the shoes and the guides. The cylinder is covered with a corrugated iron jacket which encloses a dead air space as a non-conductor. The jacketing is completed by providing a dead air space in the cylinder head. The piston is a single casting cored thin, giving maximum strength with minimum weight, and causing as little wear on the bottom of the cylinder as possible.



Two or more packing rings are used on the piston. The rod is turned to a taper fit and is secured by a single nut. A balanced piston valve is used and the valve pistons are also cast hollow and are fitted with shell rings. These rings are of the same width as the piston on which they fit, and are therefore flush with the sides. This feature prevents wire drawing of the steam as well as giving a large bearing surface to the valve. The rings have a projecting flange on the inner side which is securely clamped between the two piston faces, and held by jam nuts. By loosening these jam nuts the rings are allowed to readjust themselves to the bore, and then the nuts can be tightened, thereby securing them in that position.

The valve motion is derived from an eccentric which carries the valve rod in a straight line. The eccentric strap is lined with babbitt metal of the best quality, and the trouble so common to eccentrics where cast-iron straps work on cast-iron sheaves is entirely eliminated by this arrangement. The valve motion is controlled by a fly wheel governor of the most sensitive type. This governor is provided with three means of adjustment, so that it may be accurately set to control the engine at any given speed. One of the prominent features of this engine is its system of lubrication. The engine runs in oil and a positive means of lubrication is thereby furnished for the main bearings, the crank pin, wrist pin and cross head slides. But where no especial means is provided for the lubrication of the wrist pin of an engine running in oil (the oil which splashes upon it being relied upon as sufficient for proper lubrication) it is liable to heat and wear. An ample supply of oil for the wrist pin is insured in the Buffalo engine by the attachment of a lipped cup to it. This cup is continually filled with oil thrown back by the crank discs, and the lip prevents it from spilling out again. The wrist pin is hollow and leads the oil to the interior of the cross-head, where it feeds to the bearings. A pocket or receptacle in the interior of the bed is located on each side of the chamber near the top and catches oil thrown from the crank discs and feeds it to the main bearings through the grooves provided. The oil is prevented from leaking out on the engine by the small receptacles located beneath, as it is caught by them and returned to the oil chamber. An oil-tight side plate on either side of the frame encloses the cross head and slides. These plates may be easily removed, allowing access to the cross-head from either side. They are fastened on by four latches each, which are controlled by a lever on each plate. The crank shaft and connecting rod are of forged steel and the crank pin is of the same diameter as the shaft. The connecting rod is fastened to the crank pin by means of a strap and wedge. The wedge is completely enclosed by a strap and box



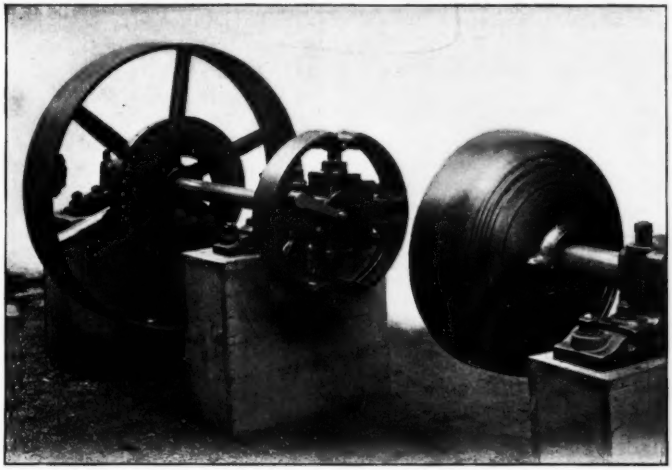
and is securely held and adjusted by two lock bolts.

This engine is built for either belt or direct connection and when directly connected is equipped with an extended sub-base and an outboard bearing. The direct attached generator shown is of the General Electric Company's make and is from a photograph of a large unit in the works of the Wagner Palace Car Company, Buffalo, N. Y

Vacuum Bailing Tank.

THE vacuum bailing tank here illustrated is manufactured by Fraser & Chalmers,

Chicago, Ill. By its employment the difficulties and inconveniences usually experienced in removing limited quantities of water from the uncompleted shaft are obviated. The apparatus consists of a large vacuum tank which may be lowered and hoisted rapidly in the shaft by means of an ordinary hoisting or winding engine located on the surface. The tank is lowered to a point near the bottom of the shaft and connected by means of a coupling with the vacuum pipe leading to the vacuum pump on the surface which may be driven continuously or intermittently by steam, compressed air, electric current, water power or otherwise as may be most convenient. The



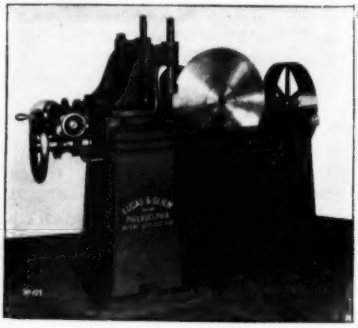
operation of this pump produces the vacuum in the tank which draws the water from the shaft bottom through a strainer foot-valve, suction hose and suction valve. When the tank is filled with water, the coupling is loosened and the tank is then hoisted to the surface to be emptied and returned to the bottom of the shaft, where it is reconnected with the vacuum pipe and is then ready for refilling. The coupling is preferably connected with the vacuum pipe and with the tank by means of flexible vacuum hose so as to occupy a position readily accessible to the miner, and is most suitably constructed to cut off the air-intake when uncoupled and open the same when coupled. Similar couplings are in common use for other purposes at the present time.

The tank is best provided with shoes to run in guides in the shaft. Its construction also involves the use of a self-dumping valve operated by a rod passing through a stuffing box at the top of the tank and connected with a lever which is automatically tipped by a stationary guide at the surface, the discharging water being carried through a water trough. Similar arrangements for automatically emptying the tank are commonly used in bailing. Additional hoisting capacity is not required where double hoists are already provided, as is very frequently the case—one for each of two compartments. The utilization of one hoisting compartment for bailing while sinking as a rule is not objectionable, as shafts generally have two or more compartments, only one of which is used for hoisting the rock from the bottom of the shaft. The tank is described as specially designed for use in vertical shafts, but it may be adapted to inclines. This apparatus lifts air, water, mud, sand, etc., with less than the usual amount of wear and tear, necessitates less labor in handling and is more easily kept in order than the sinking pumps in ordinary use.

The Herschmann Clutch.

THE accompanying engraving represents a hydraulic automatic clutch patented in the United States and Europe by Arthur Herschmann, of 28 West Twenty-fifth

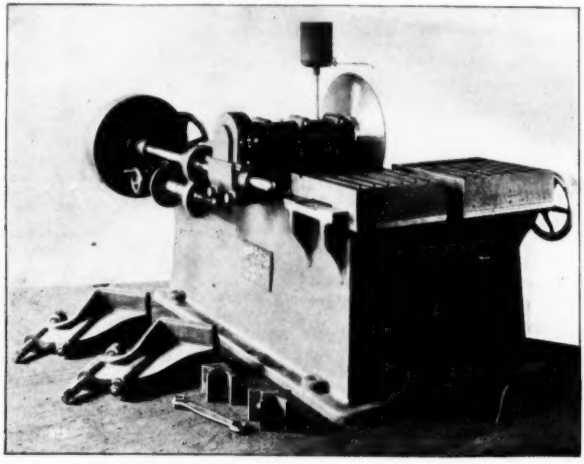
street, New York. Though hydraulically operated, there are no stuffing boxes in this clutch, or joints liable to give trouble. The action is as follows: A small steel ram is moved in and out radially by the lever, clearly shown in the cut, when the clutch



works, forcing oil from a recess in the casting under two leather cups situated beneath the toggle joints shown. The cups swelling like the tire of a bicycle, distend the springy cast iron inner half of the clutch until a powerful engagement is effected. As soon as this occurs pumping ceases, there being no more relative motion in the parts. To release this clutch it is, even in the big sizes, only necessary to open a small by-pass valve to liberate the powerful cast iron springs which effect the disengagement with the same force as the engagement, being simply the reaction thereof.

Cold Saw Machines.

THE accompanying engravings represent two types of cold saw cutting off machines built by Lucas & Gliem, of Philadelphia. One is designed for sawing out engine crank shafts. The feed mechanism is placed at the rear end of the machine, leaving the whole of the front end clear for work. The gearing is located under the shaft in order that the feed may be operated conveniently from in front of the pulley, thus giving the machine an advantage in economy of space. The tables are adjusted by the hand wheel shown on the right side of the machine, and are arranged so that both may be adjusted together or either table adjusted independently of the other. There is a drip pan under the saw, provided with a strainer. All chips are caught by the strainer and the water drained from them into the pan. In this way the water may be used continually and its cleanliness is assured. In sawing a crank holes are first drilled through the web of the crank, and after the tables on the machine have been adjusted so that the distance between them is a little more than the width of the piece



desired to be cut out, the crank is clamped in V-blocks and the sawing done. After drilling and sawing the web is broken out and the crank finished in a lathe. The machine has a capacity for sawing to the depth of 6 inches, and is driven with a two-

step cone pulley, giving two changes of speed to the saw, one for hard and the other for soft metals. The machine has a variable automatic feed and an automatic stop.

Another shows a bar cold saw cutting off machine, having a capacity for cutting round bars up to 6 inches and square bars up to 5 inches. The machine is intended principally for cutting round or square bars of iron and steel, but small I-beams, channels, rails and many other shapes within the capacity of the machine may be cut. The machine is provided with a variable automatic feed controlled by friction plates, and also an automatic safety stop. The rate of feed is regulated by the small hand wheel shown on the end. The saw runs in a bath of oil which keeps it well lubricated at all times, and the pan around the table catches all the oil from the saw, work and table and drains it back into the saw tank, thus keeping the oil from running down the sides of the machine and onto the floor.

Further details and descriptive matter will be sent by the makers on request.

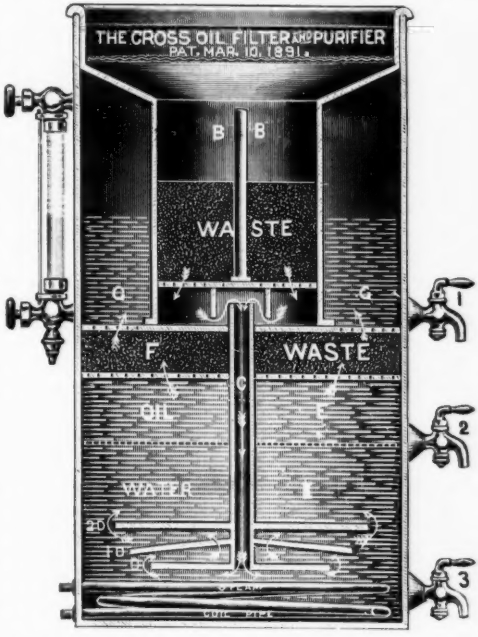
The Cross Oil Filter.

EVERY user of lubricating oil appreciates the fact that the larger portion of all the oil he buys is not consumed by the machinery on which it is used, but because of the entrained dirt and grit it is thrown away as waste. The lubricating properties are not affected, and if the impurities can be eliminated the oil may be used over and over again with safety.

The accompanying cut illustrates the interior of the Cross oil filter designed to remove these impurities from lubricating oil. The shell is made of heavy galvanized iron, all joints being soldered, lapped and riveted, having brass fittings and nickel-plated rim.

The operation of the filter is as follows: The bottom chamber (E) is filled with warm water, which is heated by means of a steam pipe passing through the filter. Very little steam is required, and if the filter is kept in a warm place, it will not be necessary to make steam connection at all.

The waste oil is poured in through top grating, passing thence into chamber B, through the layer of waste, which collects all the heavier impurities. From here it passes through the perforated bottom of chamber B, down in the direction shown by the arrows into tube C, and from here onto filter plate D, where the increased weight of the water has a tendency to keep



the oil back in tube C. However, the pressure of oil in chamber B forces it down and spreads it out over plate D, in a very thin film, which constantly changes surface and grows thinner as it travels from the center to the circumference of plate D, thus exposing every particle of waste oil to the action of the water. It then flows upon plate D′ and D″, going through the same process in each case. When the oil leaves the filter plate D″ it is in a finely divided state of separation and thoroughly mixed with water which washes it out and from which it separates by gravity all the remaining impurities, which settle in chamber E,

and can be removed through cock No. 3. From plate D" the oil again filters through the stratum of filtering material F, and from there it rises to chamber G, the reservoir containing the purified oil. It is then drawn off as required from cock No. 1.

Practically no attention is required after the filter is started, and the first cost is the only expense, excepting a few cents per year for waste. This filter is made by the Burt Manufacturing Co., Akron, Ohio, who will furnish fully-illustrated descriptive matter and other information on request.

Industrial Notes.

At a recent meeting of the board of control of the Michigan College of Mines, Professor Fred W. McNair was unanimously elected president of the institution. Professor McNair has been for some years in charge of the department of mathematics and physics, and so closely identified with the work and growth of the college that its history, aims and methods are entirely familiar to him. Professor McNair is a young man of sterling character, fine executive ability, an energetic and successful teacher.

Among the structural work now in hand by the Berlin Iron Bridge Co., East Berlin, Conn., the following are to be mentioned: A new foundry building and a one-story building for the Wheeler & Wilson Manufacturing Co.; a new furnace building, 90 ft. wide, 130 ft. long, and 22 ft. high, entirely of steel, for the Raritan Copper Co.; a fire-proof store house, 40 ft. wide and 60 ft. long, for the Armstrong Manufacturing Co.; a warehouse building, 40 ft. wide, 120 ft. long, and 20 ft. high, to be erected in Dutch Guiana; and a factory extension for the Port Chester Bolt & Nut Co. The extension is 32 ft. wide and 125 ft. long. The supporting trusses and columns are of steel; the roof is of weave shed form, having a glass exposure on the north. The same company also have an order from the Council of Rangitikei County, New Zealand, for a highway bridge of a single span of 204 ft., designed to carry a distributed load of 1,500 pounds per lineal foot, or a road engine weighing forty tons.

The Direct Separator Company, of Syracuse, N. Y., report a large number of sales recently, one firm having sent them a duplicate order for eighteen steam separators; another the tenth order of four large ones, making thirty-nine separators in use by this company; another company the forty-ninth order, making one hundred separators in use by them. These duplicate orders of which they have received so many are increasing all along the line.

The Bullock Electric Mfg. Co., of Cincinnati, O., are experiencing the practical results of prosperous times coupled with a record for high grade electrical machinery. Their new factory, with treble the capacity of their former works, and with new tools being added almost daily, finds it very difficult to supply promptly the machines called for by its sales department. This difficulty, however, will soon be obviated by increased facilities. Numerous special machine tools, which have been delayed by the crowded condition of the maker's factories, are soon to arrive, and with these in operation it will be possible to deliver more promptly.

Merchant & Co., Philadelphia, are making themselves widely known and felt in the mixed metal business. They have been manufacturing babbitt metals, solders and newspaper metals for a great many years and are generally recognized as being highly reputable manufacturers, thoroughly progressive and up to date in their methods and practice, and compared with quality, they are very reasonable in price. The activity they are experiencing from orders in this line of goods indicates that the trade and users of this material all over the country appreciate their product and prices.

The Barr Pumping Engine Co., Philadelphia, have recently secured a contract from the city of New Brunswick, N. J., for a 6,000,000 gallon high-duty crank and fly-wheel pumping engine of their special pattern. This company are now very busy on water-works and trade pumps. They have orders on hand for vertical cross-compound pumping engines for Gloucester, Mass.; Oil City, Pa.; Kittanning, Pa., and Attleboro, Mass.